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BOSTON'S FREE MUNICIPAL BATHING PLANT.

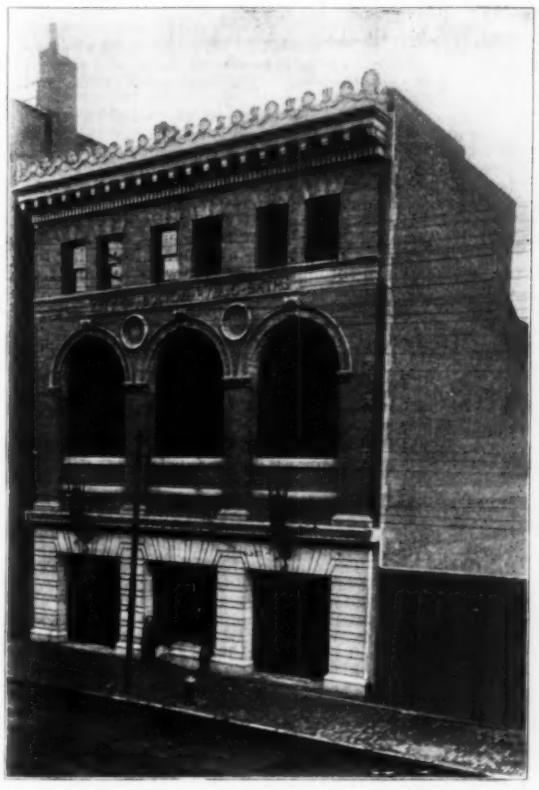
By J. A. STEWART.

PUBLIC baths properly constructed and handled form one of the most effective and far-reaching of municipal institutions for the promotion of cleanliness, good health, and good citizenship. The experience of Boston as a pioneer in the management of free municipal baths is highly instructive to cities looking to civic development in the direction of ministering to the practical and essential needs of the community.

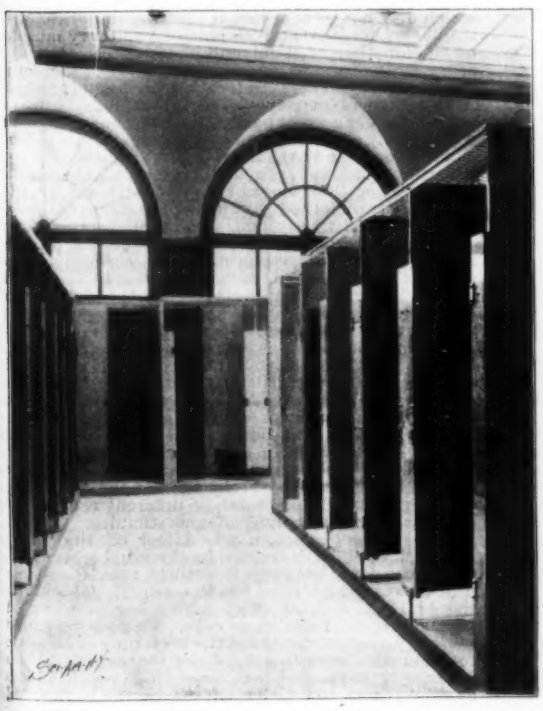
The first public baths were erected in Boston by order of the Common Council, in 1866, $10,000 being appropriated for the purpose. These were the first public baths established by a municipality in this country. At the outset the provision was for a system of baths distributed at various points on the large extent of shore line rather than for a few large central establishments, as is the British plan.

Of the five floating baths constructed at that time, at a cost of $3,500 each, the general type was a low, wooden building, supported on a floating platform. Within each was a shallow tank through which the water flowed freely. Air and light were admitted through the roof. There were the usual dressing closets and hooks for clothing.

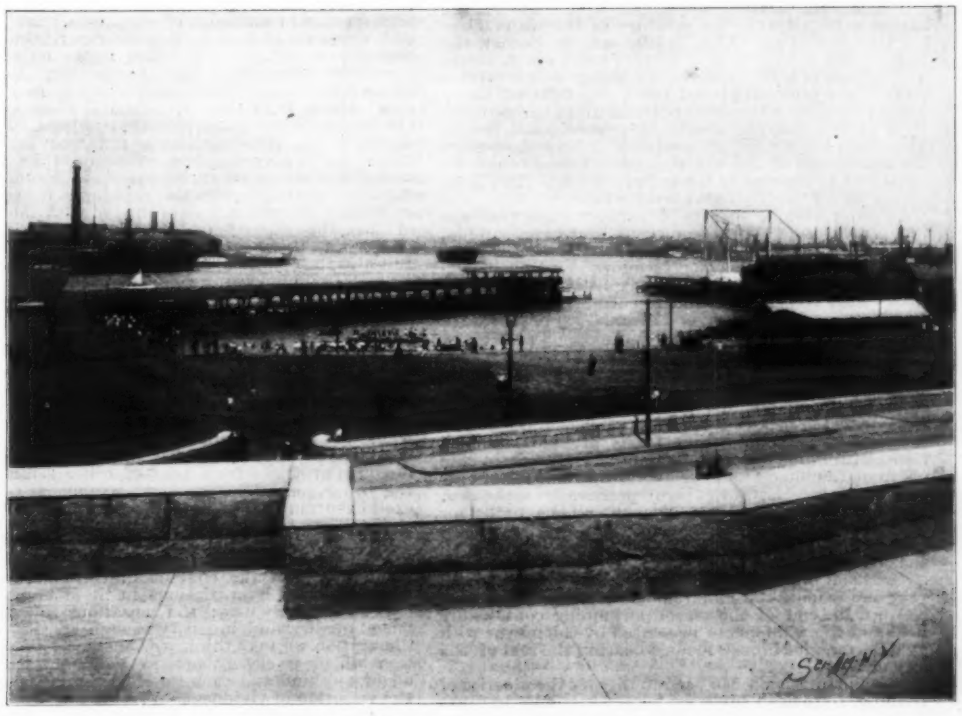
SWIMMING POOL, ORCHARD PARK.



DOVER STREET BATH-HOUSE.



SPRAY CABINS, DOVER STREET BATH-HOUSE.



BATHING BEACH, NORTH END PARK, SHOWING PLEASURE PIERS.

BOSTON'S NEW BATHING ESTABLISHMENTS.

Boston's present plant has greatly expanded under Mayor Quincy's public-spirited regime and under control of the new city department of baths, with Thomas J. Lane, chairman. From 14 stations in 1897, the plant increased in number to 23 in 1898, with nearly 2,000,000 bathers, an increase of 1,250,000 over the previous year. The cost of maintenance last year was $35,000.

The number of floating baths has been raised to ten. In the new style of floating bath devised by a member of the board, the tank is left open to the sky, thus insuring perfect ventilation and facilitating the drying of the floors and walls of the interior. The tank is 30×60 feet, with a capacity of 1,200 to 1,500 per day. This is nearly double the number accommodated by the old style floating houses. Additional space is gained by two runways extending along either side and fitted with gymnasium lockers in place of dressing closets. One runway is reserved for adults, the other for children.

Fresh water sprays have been added by the new board to the beach and floating baths to increase their usefulness and popularity.

Two swimming pools were established to supply summer baths to the inland population. One of the pools is located at Orchard Park, a small open space with grass and trees, contiguous to the tenement district of Roxbury. The tank, 30 by 80 feet, is inclosed by a high board fence. It is constructed of concrete, and is 4 feet deep at the adults' and 2 feet deep at the children's end. Fresh water amounting to 80,000 or 90,000 gallons daily is supplied by the city pipes. Several polling booths have been temporarily fitted up for dressing rooms. Great care is exercised to keep the water clean. The surface is drained off several times daily, and once each day the tank is completely emptied and washed out. From 1,200 to 1,500 patrons daily attend this bath. The hours are divided, men at early morning and evening, boys in the forenoon, and women and girls in the afternoon. The entire cost of the pool was $2,000.

The concrete pool built inside of the ward 18, ward-room on Cabot Street, at the same cost, measures 20 by 60 feet, and has a capacity ranging from 1,000 to 1,400 persons daily. A unique feature of this pool is that it is floored over during election time. The most important of Boston's eight beach baths is that at the North End Park, completed two years ago, which, with its pleasure piers and improvements, cost the city $350,000. Thirty people are employed in caring for the cosmopolitan throng of bathers, who number frequently 5,000 daily.

The new all-the-year public bath-house, on Dover Street, whose erection was provided for by the mayor early in his term of office, is admirably adapted for the purpose in view. It cost $86,000. The building is a substantial brick structure 43 feet wide by 110 feet deep. The front rises three stories from the street. The first story is of granite; the upper portions are of gray mottled brick with limestone trimmings. A row of three-arched windows extends across the second story. The whole is topped by an ornamental cornice of galvanized iron. The two entrances from the street are into separate waiting rooms, one for men and one for children. Windows look into both from the central office of the superintendent, from which the soap and towels are dispensed. The laundry and engine room are in the rear. The separate bathrooms for men and women are on the second floor. Above is an apartment for the superintendent and his family.

The waiting rooms are supplied with wall benches. These and the bathrooms are wainscoted with ⅝ inch thick Knoxville marble and have floors of terazzo mosaic. The ceilings are plastered on brick arches.

The bathrooms are reached by wide marble staircases from each waiting room. The men's bathing apartment measures 40 feet by 48 feet and is 19½ feet high. The women's is 27×40 and 21 feet high. In appointments they are exactly alike, excepting that the men's room is provided with 30 inclosed shower baths and 3 inclosed tubs, while the women have 11 shower baths and 6 bath cabins. Each shower cabin contains a dressing alcove and marble seat, beyond which is the spray alcove. The partitions and backs of the compartments are of marble. Each bath division contains a Gegenstrum heating apparatus, which enables the bather to regulate the temperature of the water flowing from the spray. After falling over the bather, the water drops upon a dished marble floor which serves the purpose of a footbath as the water slowly drains away. The plumbing is all open, the tubs of heavy white porcelain with nickel plated fittings throughout. Both of the bathing apartments have toilet rooms. The steam supply for all purposes is furnished from the boiler room of the fire department repair shop, located just at the rear of the bath-house lot. The laundering for all the city baths is done here.

An innovation by the city department last year was the purchase of the bathing suit and towel supply, formerly owned by the superintendents, who derived from their rental an income in addition to their salaries. The city possesses at present 1,200 girls' one part suits; 1,200 women's suits in two parts; 1,800 men's two part suits; 1,200 men's trunks, and 3,600 boys' trunks for the floating baths; and 15,000 towels. The revenue from this source last year was $3,500.

In addition to trained attendants who patrol the shore and are constantly at hand to prevent swimmers from venturing out too far, certain employes have been drilled in means for resuscitating the apparently drowned. Surgical equipment is provided at each bath, with liniment for bruises, Jamaica ginger in case of cramp, ammonia for syncope, and bandages for cuts and sprains. Fatalities are practically unknown. Swimming instruction was given at all the baths for the whole or part of last season. In preparation for this, and also to connect the baths more directly with the city schools, the head instructor visits the public educational institutions before the close of the school year and teaches the children the swimming motions. Toward the end of the season swimming contests are held and the winners are presented by the mayor with gold, silver, and bronze medals bearing the seal of the city of Boston.

The aim in Boston has been to dignify the practice of bathing, to furnish innocent recreation, and to cause the people to regard the bathing establishments as necessary to their well-being as are the city water supply, the sewerage system, the schoolhouses, libraries, or parks.

THE PHYSIOLOGICAL BASIS OF MENTAL LIFE.*

IF we demand a physiological process corresponding to every possible variation of the content of consciousness, the structure of the brain seems far too uniform to furnish a sufficient manifoldness of functions. The mere number of elements cannot be decisive; if they are all functionally co-ordinated, they can offer merely the basis for co-ordinated psychical functions. If we have psychical functions of different orders, it would not help us even if we had some millions more of the uniform elements. It would be useless to deny that here exists a great difficulty for our present psychology; the only question is whether this difficulty really opposes the demands and suppositions of psychophysical parallelism or whether it means that the usual theories of to-day are inadequate and must be improved. It seems to me that the latter is the case, and that hypotheses can be constructed by which all demands of psychology can be satisfied without the usual sacrifice of consistency. The situation is the following:

The whole scheme of the physiologists operates to-day in a manifoldness of two dimensions: they think the conscious phenomena as dependent upon brain excitements which can vary first with regard to their localities and secondly with regard to their quantitative amount. These two variations then correspond to the quality of the mental element and to its intensity. In the acoustical center, for instance, the different pitch of the tone sensations corresponds to locally different ganglion cells, the different intensities of the same tone sensation to the quantity of the excitement. Association fibers whose functions are not directly accompanied by conscious experiences connect these millions of psychophysical elementary centers in a way which is imagined on the model of the peripheral nerve. No serious attempt has been made to transcend this simple scheme. Certainly recent discussions have brought many propositions to replace the simple physiological association fiber which connects the psychophysical centers by more complicated systems—theories, for instance, in regard to the opening and closing of the connecting paths or in regard to special association centers or special mediating cell groups—but these and others stick to the old principle that the final psychophysical process corresponds to the strength and locality of a sensory stimulation or of its equivalent reproduction, whatever may have brought about and combined the excitements.

It is true that it has been sometimes suggested that the same ganglion cell may go over also into qualitatively different states of excitement, and thus allow an unlimited manifoldness of new psychophysical variations. But it is clear that to accept such an hypothesis means to give up all the advantages of brain localization. The complicatedness of the cell would be in itself sufficient to give ground to the idea that its molecules may reach some millions of different local combinations, and if every new combination corresponds to a sensation, all the tones and colors and smells and many other things may go on in one cell. But, then, it is, of course, our duty to explain those connections and successions of different states in one cell, and that would lead to thinking the cell itself as constructed with millions of paths just like a miniature brain; in short all the difficulties would be transplanted into the unknown structure of the cell. If we, on the other hand, do not enter into such speculations, the acceptance of qualitative changes in the cell would bring us to the same point as if we were satisfied to speak of qualitative changes of the brain in general. It would not solve the problem, but merely ignore it, and, therefore, such an additional hypothesis cannot have weight.

The only theory which brings in a really new factor is the theory of innervation feelings. This well-known theory claims that one special group of conscious facts, namely, the feelings of effort and impulse, are not sensations and, therefore, not parallel to the sensory excitements, but are activities of consciousness and parallel to the physiological innervation of a central motor path. At this point, of course, comes in at once the opposition of the philosophical claim that every psychical fact must be a content of consciousness, and made up of sensations, that is, of possible elements of idea, to become describable and explainable at all. The so-called active consciousness, the philosopher must hold, has nothing to do with an activity of the consciousness itself, as consciousness means, from the psychological standpoint, only the kind of existence of psychical objects. It cannot do anything, it cannot have different degrees and functions, it only becomes conscious of its contents, and all variations are variations of the content, which must be analyzed without remainder into elements which are theoretically co-ordinated with the elements of ideas, that is, with the sensations, while consciousness is only the general condition for their existence. But also the empirical analysis and experiment of the practical psychologist are in this case in the greatest harmony with such philosophical claims and opposed to the innervation theory. The psychologist can show empirically that this so-called feeling of effort is merely a group of sensations like other sensations, reproduced joint and muscle sensations which precede the action and have the rôle of representing the impulse merely on account of the fact that their anticipation makes inhibitory associations still possible. It would thus from this point of view also be illogical to think the psychophysical basis of these sensations different in principle from that of other sensations. If the other sensations are accompaniments of sensory excitements in the brain, the feelings of impulse cannot claim an exceptional position.

But are quality and intensity really the only differences between the given sensations? Can the whole manifoldness of the content of consciousness really be determined by variations in these two directions only? Certainly not; the sensations can vary even when quality and intensity remain constant. As an illustration we may think, for instance, of one variation which is clearly not to be compared with a change in kind and strength of the sensation; namely, the variation of vividness. Vividness is not identical with intensity: the vivid impression of a weak sound and the unvivid impression of a strong sound are in no way interchangeable. If the ticking of the clock in my room becomes less and less vivid for me the more I become absorbed in my work, till it finally disappears, it cannot be compared with the experience which results when the clock to which I give my full attention is brought farther and farther away. The white impression, when it loses vividness, does not become gray and finally black, nor the large size small, nor the hot lukewarm. Vividness is a third dimension in the system of psychical elements, and the psychologist who postulates complete parallelism has the right to demand that the physiologist show the corresponding process. There are other sides of the sensation for which the same is true; they share with vividness the more subjective character of the variation, as, for instance, the feeling tone of the sensation or its pastness and presentness. Other variations bring such subjective factors into the complexes of sensations without a possibility of understanding them from the combination of different kinds only, for instance, the subjective shade of ideas we believe or the abstractedness of ideas in logical thoughts. In short, the sensations and their combinations show besides kind, strength and vividness still other variations which may best be called the values of the sensations and of their complexes. Is the typical theory of modern physiological psychology, which, as we have seen, operates merely with the local differences of the cells and the quantitative differences of their excitement, ever able to find physiological variations which correspond to the vividness and to the values of the sensations? An examination without prejudice must necessarily deny this question. Here lies the deeper spring for the latent opposition which the psychophysiological claims find in modern psychology. Here are facts, the opponents say, which find no physiological counterpart, and we must, therefore, acknowledge the existence of psychological processes which have nothing to do with the physiological machinery. The vividness, for instance, is fully explained if we accept the view that the brain determines the kind and strength of the sensation, while a physiologically independent subject turns the attention more or less to the sensation. The more this attention acts, the more vivid the sensation; in a similar way the subjective acts would determine the feeling tone of the sensation by selection or rejection, and so on. While the usual theory reduces all to the mere association of locally separated excitements, such a theory thus emphasizes the view that the physiologically determined functions must be supplemented by an apperceiving subject which takes attitudes. We may call the one the association theory, the other the apperception theory. We have acknowledged that the association theory is insufficient to solve the whole problem, but it is hardly necessary to emphasize that the apperception theory seeks the solution from the start in a logically impossible direction, and is thus still more mistaken than the association theory.

The apperception theory, whatever its special label and make-up may be, does not see that the renunciation of a physiological basis for every psychical fact means resigning the causal explanation altogether, as psychical facts as such cannot be linked directly by causality, and that resigning the causal aspect means giving up the only point of view which comes in question for the psychologist. If those apperceptive functions are seriously conceived without physiological basis they represent a manifoldness which can be linked merely by the teleological categories of the practical life, and we sink back to the subjectifying view which controls the reality of life, but which is in principle replaced by the objectifying view as soon as the experience of the subject is acknowledged as a series of psychological objects.

But does this bankruptcy of all varieties of apperception theories necessarily force us back to the association theory? I do not think so. The demand of the association theory that every psychosis should be accompanied by a neurosis cannot be given up, but this neurosis may be thought in a richer way than in the scheme of the associationists. It seems to me, indeed, that the physiological theory works to-day with an abstract scheme with which no observation agrees. We do not know of a centripetal stimulation which does not go over into centrifugal impulses. The studies on tonicity and actions of voluntary muscles, on the functions of glands and blood vessels, on tendon reflex centers, and so on, show how every psychophysical state discharges itself into centrifugal functions. And yet these perceivable peripheral effects are, of course, merely a small part of the centrifugal impulses which really start from the end stations of the sensory channel, as most of them probably produce only new dispositions in lower motor centers without going directly over into movement, and others may fade away in the unlimited division of the discharge in the ramification of the system. Those milliards of fibers are not merely the wires to pull a few hundred muscles; no, the centrifugal system represents certainly a most complex hierarchy of motor centers too, and the special final muscle impulse is merely the last outcome of a very complex co-operation of very many factors in the centrifugal system. Manifold as the incoming nerve currents must be, thus, also the possibilities of centrifugal discharge, and the dispositions in the nervous motor system determine the degrees in which the ganglion cells can transform the centripetal into centrifugal stimulation. It is thus not only the foregoing sensory process, but in exactly the same degree also the special situation of the motor system, its openness and closedness, which governs the process in the center. Whether the special efferent channel is open or plugged implies absolutely different central processes in spite of the same afferent stimulus.

Here we have, then, a new factor on the physiological side which is ignored in the usual scheme that makes the psychical facts dependent upon the sensory processes only and considers the centrifugal action of the brain as a later effect which begins when the psychophysical function is over. There is no central sensory process which is not the beginning of an action too, and this centrifugal part of the central process necessarily varies the accompanying psychical fact also. As here the action of the center becomes the essential factor in the psychophysical process, we may call this view an action theory as over against the association and apperception theories of the day. The action theory agrees, then, with the associationism in

* Read before the joint meeting of the Psychological Association and the Physiological Society. By Prof. Hugo Munsterberg, of Harvard University. —From Science.

the postulate that there is no psychical variation without variation on the physiological side and with the apperceptionism in the conviction that the mere association of sensory brain processes is insufficient to play the counterpart to the subjective variation of the psychical facts as vividness and values of the sensations. It tries to combine the legitimate points in both views, and claims that every psychical sensation as element of the content of consciousness is the accompaniment of the physical process by which a centripetal stimulation becomes transformed into a centrifugal impulse.

This central process thus clearly depends upon four factors: first, upon the local situation of the sensory track; secondly, upon the quantitative amount of the incoming current; thirdly, upon the local situation of the outgoing discharge; and fourthly, upon the quantitative amount of the discharge. The first two factors are, of course, determined by the incoming current, which can be replaced by an intracortical stimulation from an associated center, while the last two factors are determined by the dispositions of the centrifugal system. The association theory, which considers the first two factors alone, thinks them parallel to the kind and strength of the sensation. The action theory accepts this interpretation and adds that the two other factors determine the values and the vividness of the sensation—the values parallel to the local situation of the discharge, the vividness to the openness of the centrifugal channel, and thus to the intensity of the discharge.

If the centrifugal discharge is inhibited, the channel closed, then the sensory process goes on as before, but the impression is unvivid, unperceived, while it may become vivid later as soon as the hindrance of the discharge disappears. The inhibition of ideas which remains unexplainable to the associationists would then mean that a special path of discharge is closed, and thus the idea which needs that discharge for its vividness cannot come to existence; the hypnotizer's words, for instance, close such channels. Only discharges, actions, can be antagonistic and thus under mutual inhibition; ideas in themselves may be logically contradictory, but not psychologically, while one action makes the antagonistic action, indeed, impossible and the inhibition of ideas results merely from the inhibition of discharges. If this view is correct, it is clear that while we strictly deny the existence of special innervation sensations we can now say that every sensation without exception is physiologically an innervation sensation, as it must have reached some degree of vividness to exist psychologically at all.

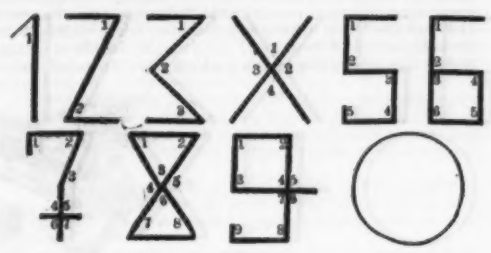
With regard to the local situation of the motor discharge the manifoldness of possibilities is evident. The channels may be closed in one direction, but open in others; the actually resulting discharge must be the product of the situation in the whole centrifugal system, with its milliards of ramifications, and the same sensory stimulus may thus under a thousand different conditions produce a thousand different centrifugal waves, all, perhaps, with the same intensity. The vividness would then be always the same, and yet the difference of locality in the discharge must give new features to the psychical element. A few cases as illustrations must be sufficient. We may instance the shades of time-direction; the same idea may have the subjective character of past, present and future. It corresponds to three types of discharge: the discharge which does not include action on the object any more appears as past, that which produces action as present, and that which prepares the action as future. In this group belong also the feeling tones: the pleasurable shade of feeling based on the discharge toward the extensors; the unpleasant feelings based on the innervation of the flexors. Here belong the differences between mere perception and apperception, as in the one case the discharge is determined by the impression alone, in the other case by associations also. Here belong the characteristics of the abstract conception which may be represented by the same sensational qualities which would form a concrete idea and yet has a new subjective tone because the centrifugal discharge is for the concrete idea a specialized impulse, for the conception a general impulse which would suit all objects thought under the conception. Here belongs, also, the feeling of belief which characterizes the judgment; the judgment differs psychophysically from the mere idea in the fact that the ideas discharge themselves in a new tonicity, a new set of the lower motor centers, creating thus a new disposition for later reactions. To be sure, many of these discharges lead finally to muscle contractions which bring with them centripetal sensations from the joints, the muscles, the tendons, and these muscle and joint sensations themselves then become a part in the idea, for instance, of time, of space, of feeling. But the new part only reinforces the general tone which is given in the general discharge, and gives to it only the exact detail which gets its character just through the blending of these sensations of completed reactions with the accompaniments of the central discharge.

A consistent psychology thus may start with the following principles: It considers all variations of mental life as variations of the content of consciousness, and this content as a complex object, including in this first presupposition a complicated transformation of the real in a life, a transformation by which the subjectifying view of real life is denied for the causal psychological system. Every content of consciousness is further considered as a complex of sensations, that is, of possible elements of perceptive ideas. Every sensation is considered as having a fourfold manifoldness, varying in kind, in strength, in vividness and in value. The physiological basis of every sensation, and thus of every psychical element, is the physical process by which a centripetal stimulation becomes transformed into a centrifugal impulse, the kind depending upon the locality of the centripetal channel, the strength upon the quantity of the stimulus, the value upon the locality of the centrifugal channel, and the vividness upon the quantity of the discharge.

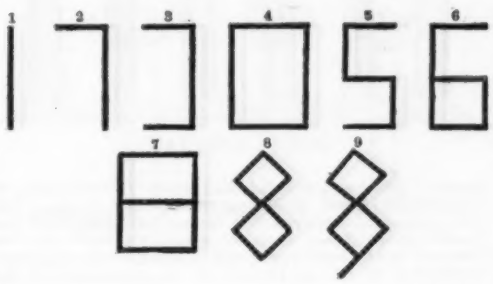
A train of ten refrigerator cars, each loaded with 450 cases of eggs, was recently shipped by the Kansas Ice and Storage Company from Salina, Kas., en route to Springfield, Mass. The eggs were gathered from Kansas farms and the train was hauled into Kansas City over the Union Pacific Railway.

ORIGIN OF ARABIC NUMBERS.

DI CORNEGLIANO, in the Genoa Cattolico Militarite, traces back the origin of the Arabic numbers to the fact that the Arabians, being excellent geometricians, formed their numbers from simple geometric figures whose angles were counted:



Opposing this interpretation, a Hamelin reader of the Hann. Courier points out that the Arabians borrowed their figures from the Hindoos and consequently they should be called Hindostanee numbers. This authority starts from the square as the fundamental figure and thus obtains the following fundamental figure (square, double square, two-squares):



From the shape of the lines put together and corresponding in number with the respective figure, the names originated, at first in Latin, e. g., noveur, nine, the newly added line, novum adjectum; octo, eight, eye-shaped, oculatum; septem, seven, inflection, septum; sex, six, incision, sectum (from secare).

WOMEN INVENTORS.

By GEORGE ETHELBERT WALSH.

THE Patent Office at Washington is teeming with inventions that are of great benefit to humanity, and the sum total of brains represented by these products speaks eloquently for American ingenuity. A person interested in the comparative study of the mental abilities of the two sexes might find in a systematic examination of these patents considerable data for reflection and speculation. The generally accepted idea that men have monopolized all of the inventive genius of the human race does not seem to be borne out by the exhibitions of patents at Washington. Women have not only a pretty fair showing in the mere number of patents taken out, but also in their value and importance.

At the Atlanta Exposition the first display of strictly women's inventions ever made in this country was arranged by the Patent Office in the government exhibit. Not less than 125 models, showing the achievements by women in the field of invention, were shown, and many of these were as great a surprise to the women of the country as to the men. A great amount of ignorance of the inventive achievements of women has been current in the past, owing partly to the lack of interest shown by women in patents early in the present century, and to the suddenness of their development in this line. Prior to 1860 there were scarcely half a dozen patents taken out by women, and of the several hundreds now on exhibition at the Patent Office, nine-tenths of them have been invented within the past twenty years.

A number of patient and enthusiastic women have entered the field of invention, and they have produced results that command national attention. The proportion of women inventors to the men is still very small, but the applications for patents by women are steadily increasing. Two or three patents are granted nearly every week to women inventors, while dozens of applications are made by them that never see the light of day.

An examination of a hundred or more of the patents by women reveals the fact that they are invading every line of industry with their inventive genius, and that they are not by any means confining themselves to the invention of household novelties and conveniences, although in the latter work they stand high. We have patents taken out by women on agricultural implements, mining machinery, electrical contrivances, and even general railroad and mill machinery. An illustration of the variety of inventions by women may be made by citing a list of some of the patents granted to them during two consecutive months recently. A patent on building blocks, with beveled ends and alternate rows of tongues and grooves for locking them together, was taken out by Julia E. Meyenberg, of Chicago, during one of these months. Abby S. Vose, of Providence, R. I., patented during the same month an improved button-hole cutting machine, by which the distance between the button holes is automatically measured. An improved and quite intricate washing machine, with the washboard at the bottom, was patented by Cecilia A. Brewer, and a water filter by Minerva R. Buckley; a portière rope by Bertha Cronenberg, and a friction hinge by Emmeline W. Philbrook.

The official organ of the Patent Office publishes the list of patents granted every week, and the names of several women inventors appear upon nearly every page. Ten years ago it was found impossible to find a woman inventor in the lists more often than two or three times a year.

The value of the patents invented by women depends upon how one looks at the question. Quite a number of women inventors are making large royalties upon their simple inventions, and others have acquired fortunes upon more intricate products of their genius. Scores of very simple household and dress articles have been invented by women, and besides bringing in money to them they are lessening the labor of thousands of women throughout the country. A woman knows intuitively what is needed in a house, and her genius has made modern conveniences that are bringing in rich royalties every year.

There are over one hundred valuable patents taken out by women, which yield good fortunes to them annually, and many others which are destined to sell well when they have been put upon the market. One woman inventor is drawing about $5,000 a year for a simple glove buttoner, and another has coined money from a patented adjustable waist supporter. There are many health devices patented by women, such as water filters, dress supporters, shoulder braces, and exercising machines. In the matter of small inventions for simplifying woman's wardrobe, men have generally led the way, and even to-day they take out far more patents of this nature than the women. The latter, however, are very fruitful in inventing toys, puzzles, and games for young people, and some of our most successful ones are placed to their credit. The demand for new games and toys is becoming so great in our cities that a number of women inventors make a big income in contriving something new in this line every season. Many of their inventions are not patented in their name, but firms and dealers in toys and games buy the thing outright from them and secure the patent. Consequently the real inventors do not receive the credit due to them, and the official record does not tell the whole story.

There are naturally many patents applied for by women that are rejected because the ideas have already been covered by others. Quite a considerable number of the applications contain ideas that are of no value whatever, and they are often rejected on the score of absurdity. But in this respect the women inventors do not differ from the male sex. More silly and irrational inventions are sent to the Patent Office than can be imagined. Many are accompanied by elaborate models and drawings, but, through the ignorance of the inventors, some vital principle of mechanics is neglected, which stamps the whole creation as absurd. One or two women have even sent in models for machines claiming to solve the mystery of perpetual motion, but as a ruling of the Patent Office has excluded all patents of this nature from consideration the applications were naturally rejected.

A number of good inventions have been patented by the same women, and it may be inferred that they make a good living at the work. Some of them control important patents that have been purchased from others, and they manufacture the articles on a large scale. One New England woman enjoys the right to several patents that were invented by some of her employés, and she shares with the inventors the profits of the articles manufactured and sold. One of these inventions brings in over $30,000 a year, and it is not improbable that some inventor finds profit and pleasure in her work. The chances of a woman making a living in invention are just as vague and uncertain as for men.

While a score of apparently valuable patents will fall dead upon the market, and bring in returns hardly sufficient to pay for the cost of models and patent fees, another very simple one struck off at random may make the inventor rich. Many of the best patents, that show real genius and knowledge, bring in small profits, while the small ones that a child might have invented pave the way to riches. There are fields for invention for women, however, that should yield good returns to those of an inventive turn of mind. Household articles are daily being patented, and who knows better than a woman what will lighten the burdens of the housewife in the kitchen and dining room? Dress reform is now in the air, and scores of women are cudgeling their brains to invent some simple devices that will make dressing for women less of a burden than it is to-day. Toys and puzzles form a wide field by themselves, and there seems no limit to the expansion of this industry. But in order to work intelligently along this line, it is necessary to become acquainted pretty generally with the patents already taken out for toys and games. The more intimate a woman becomes with the history of past inventions, the better prepared will she be for making suitable inventions herself.

Trade marks for patent medicines, complexion cures, and soaps and perfumes are also registered at the Patent Office by women in ever-increasing numbers. It is only necessary to study some of the advertisements in the papers to become familiar with enterprising women in this line. They have achieved fortune either through the merit of their goods, or through their business shrewdness in placing them upon the market.—The Independent.

The first section of the Sierra Leone Railway was opened on May 1. The section now opened for traffic is 32 miles in length, and reaches to Songo Town. Twenty-five miles more are under construction to Rotofunk, and a survey has been completed for an additional 31 miles past Moyamba, while a flying survey has also been carried to Mattvu and Bo, about 50 miles still further, making a total length of line contemplated of 138 miles. The section completed has necessitated the construction of eleven large steel viaducts in the first 18 miles, besides numerous smaller works.

An arrangement for protecting glass-blowers from the radiant heat of the glass furnace is in use, says Diamant, at the Gätcke Glass Works, at Altona-Bahrenfeld. Just below the openings through which the glass is drawn from the furnace are placed iron pipes, perforated with fine holes delivering compressed air so as to form a film of cold air in front of the aperture and thereby absorbing a good part of the radiant heat. At the same time ventilating fans above the blowers' stands are set in motion by the effluent air and assist in keeping the workers cool.

MECHANICAL INFLUENCE IN ARCHITECTURE.*

IN most popular writings on the subject of architecture and of the origin and development of architectural styles, the causes that are chiefly dwelt upon as affecting and influencing the forms and features of the various styles are climate of the country, temperament of the people, their artistic tastes, religion, traditions, occupations, etc.

In short, the esthetic and sentimental influences are credited with being the most important factors and the controlling causes in developing their national styles.

Thus we are often reminded that the light and peculiar constructions of the Japanese and Chinese are but the natural representations of the nature and characteristics of these peculiar peoples; likewise, that the massive grandeur and simple severity of Egyptian architecture but reflect the somber, austere and rigid character of the ancient Egyptians and the impressive rites of their religion; that the beautiful and majestic marble temples of Greece are but expressions of the artistic and philosophic nature of the Greek mind, while the round arch of the Romans was introduced for the gracefulness of its lines and purely for decorative effect; that Romanesque architecture was but the result of a different whim, and a desire on the part of the early Christians to cultivate a style different from that of pagan Rome.

When we come to Gothic architecture, imagination runs riot in accounting for the pointed arch and groined vaulting on sentimental grounds; and attributing to the desire to produce picturesque effects such features as the graceful pinnacles, flying buttresses and strong projections, while the lofty spires and high-reaching roofs are supposed to indicate the earnest desire of the soul to follow in the direction of the heavenly index.

While I am quite willing to admit that these and similar sentimental and esthetic reasons have made

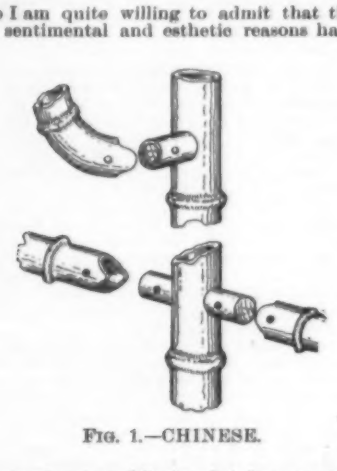


FIG. 1.—CHINESE.

their impression on architectural styles, more especially on the decorative and ornamental portions of the work, I shall attempt to show that by far the most influential factor in perfecting nearly all strictly architectural forms has been purely mechanical, in devising the best methods of employing the materials at hand, and the

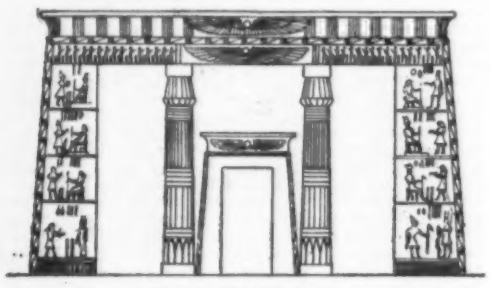


FIG. 2.—EGYPTIAN.

means used to overcome structural difficulties and resist natural forces.

In following out this idea, while examining historical styles, we shall see that generally the builders used the best judgement, skill and methods at their command, even when it led to changing forms that had become sacred by tradition and association; while sometimes, as in the case of Egyptian architecture, we may find forms and details naturally developed in one kind of material were religiously copied in other materials where they ceased to be appropriate.

So closely has all good architecture in the past followed the rules of good construction that the motto "Construction may be ornamented, but ornament should not be constructed," has become proverbial, and a very able architectural critic lays down this rule of judgment:

"A form which admits of no explanation, or which is a mere caprice, cannot be beautiful, and in architecture every form which is not inspired by the structure ought to be rejected."

Of the surface ornaments applied to their architectural forms by the Egyptians and other peoples I have nothing to say in this paper, more than to observe that they consist principally of conventionalized forms of the flowers and foliage of the country where used, and of religious emblems; and that their application is conceded to be due to esthetic and religious sentiments.

As graphic illustrations will show architectural forms more clearly than words can describe them, I have prepared a number of sketches to illustrate my meaning and make my references more clearly understood.

Without wasting time to speculate on the origin and forms of prehistoric architecture, we will refer at once to well known forms of historic times and work. In Fig. 1 are presented some simple forms of Chinese construction, in which is shown quite clearly the bamboo origin of Chinese architecture.

The properties of the bamboo are well known, and in a country where it is found in abundance, from the smallest twigs to trees 6 and 8 inches in diameter, its great strength and remarkable lightness, together with the fact that it is uniformly hollow, with webs at intervals, so that one part may slide inside a larger piece, the ease with which sockets and doweled joints

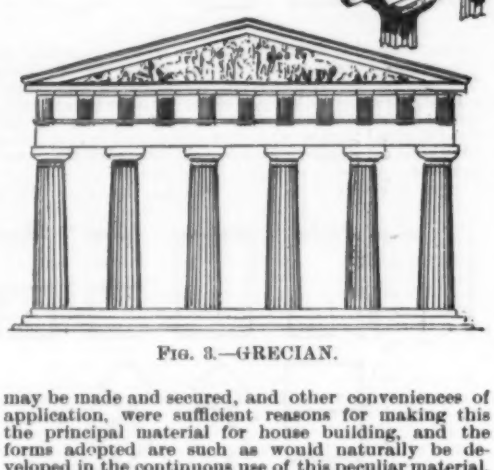


FIG. 3.—GRECIAN.

may be made and secured, and other conveniences of application, were sufficient reasons for making this the principal material for house building, and the forms adopted are such as would naturally be developed in the continuous use of this peculiar material, regardless of the sentiments or characteristics of the people.

In lower Egypt we find quite different conditions and surroundings. (See Fig. 2.) With few trees of any kind and with no stone immediately at hand, the early Egyptians erected their dwellings and other buildings with mud, reeds, and bulrushes, which they had in abundance.

On elevated platforms of earth they erected thick walls of mud, placed in situ, with layers of reeds and bulrushes to bind the whole together. For greater stability they made the walls battering on the outside, thus reducing the thickness as they approached the top.

To enable them to preserve true angles and proper batter at the angles of the proposed structure they set up corner posts, consisting of bundles of reeds, neatly tied at intervals with willows or smaller reeds.

A horizontal band of similar bundles of reeds marked the top of the wall proper, and where the thick mud roof should commence. This roof was supported by bundles of reeds laid close together and in turn supported by the walls, and by interior columns of proper strength. These columns also consisted of large bundles of reeds strongly bound together.

To confine the mud or soft clay when applied to the roof, upright reeds were placed close together and secured to the horizontal band. These would naturally bend outward from the pressure of the clay

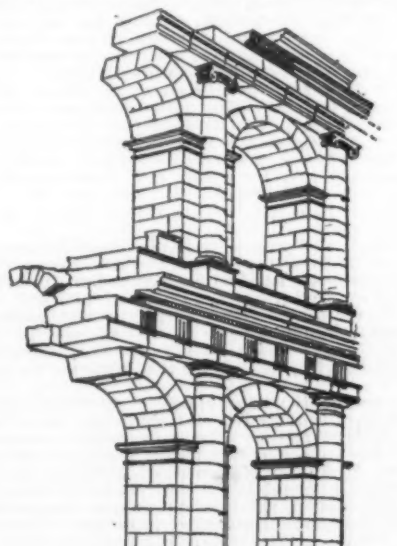


FIG. 4.—ROMAN.

on the inside, and thus produce the graceful and bold cove which forms so conspicuous a feature in Egyptian architecture.

These early structures were plastered on the outside with clay, in the fresh surface of which were easily impressed ornaments and hieroglyphics.

When this people had so far advanced as to build their temples and tombs of granite, the traditional and still prevalent forms of their mud structures were copied to the minutest detail.

Even the massive stone columns in their latest work, in many cases, show very clearly their reed origin, with well designed capitals of lotus, papyrus, and palm, reminders of the flowers and leaves with which the earlier columns were sometimes trimmed or decorated.

The ornaments and hieroglyphics so easily impressed in their mud walls were now cut with great difficulty in the hardest known building stones.

And this simple style, thus developed, was practiced as long as Egypt was a power.

The monuments of this ancient art still remaining give us on their sculptured walls the best history we have of their arts and sciences.

The development of Grecian architecture advanced on quite different lines, and it shows less clearly in the perfected temple the details of its prototype. (See Fig. 3.)

The early habitations of Greece are generally conceded to have been of wood, and the log hut, with its projecting porch supported on upright trunks of trees, is supposed to have suggested the form of the marble temple and portico.

As Greece abounded in marble and limestone easily obtainable in large blocks, the inhabitants commenced, at an early stage of their development, to build with stone; but, instead of lavishly copying the forms and proportions of log structures, they did what we should expect of a people who could evolve logic; they devised and perfected forms and proportions more appropriate for their stratified materials.

Instead of making their columns monolithic, placing the natural strata on end, they cut cylindrical sections from the thickness of the layers in the quarry. Then, cutting square holes in the center of each end, they inserted square blocks of wood, in which were fixed axles of a frame, and in this manner the great drum-like sections were rolled over the ground to the site of the proposed structure, where they were wrought to the desired size and exact form, and carefully placed in position. The Grecian columns are much more massive and set nearer together than could have been suggested by wood construction. The spreading cap and broad abacus were designed to shorten the span of the lintel and give it greater bearing surface, at the same time giving level supports for timbers on the outside

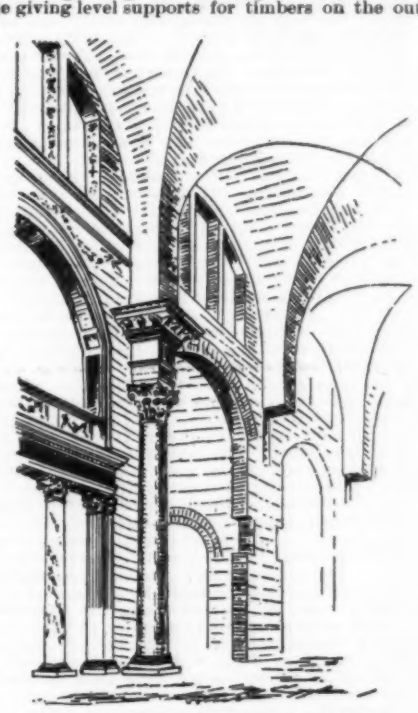


FIG. 5.—ROMAN CONCRETE WORK.

and inside of the entablature, which should serve as scaffolding and guides in placing the architraves in their exact positions. The architrave itself was made double for greater security from defects in the stone, the triglyphs and frieze to give satisfactory proportions and furnish a protected position for sculpture and ornament, while the cornice projected sufficiently to discharge the water well away from the walls. The low-pitch pediment emphasizes and makes clear the lines of the roof and explains its purpose.

The general form and application of all these parts are strictly adapted to the work they have to perform and to the materials in which they are executed, while the graceful forms of the mouldings, the flutings of columns, and ornaments of capitals and friezes, must be credited to the artists' touch after mechanical considerations had produced the general forms.

In Greek work each stone is very perfectly wrought to its proper lines and surfaces, and the blocks are fitted together with the greatest exactness, the abutting surfaces often being polished. Dowels of copper or bronze were inserted in the joints to prevent displacement by earthquakes, and no mortar was used. It was this perfect mechanical work of the Greeks that inspired Longfellow to write:

> "In the elder days of art,
> Builders wrought with greatest care
> Each minute and unseen part,
> For the Gods see everywhere."

In Rome we find still different conditions, and to meet them new mechanical principles are involved. (See Fig. 4.)

Unlike Athens, the immediate vicinity of Rome did not furnish marble or other stone suitable to be used in large blocks. A soft volcanic tufa abounded, with which the early Etruscans developed the semi-circular arch as a means of spanning openings instead of the horizontal lintel.

The discovery and first use of the arch cannot be positively accredited to the Etruscans.

It was probably in the valley of the Euphrates, where sun-dried and burnt bricks were the building material,

* By G. W. Percy, Member of the Technical Society of the Pacific Coast. [Read before the Society, March 3, 1899.] From the Journal of the Association of Engineering Societies.

that the important discovery was made that a wall of masonry could be safely carried over openings by the use of small wedge-shaped blocks placed with the large ends outward so as to form an arch or bow over the opening. This discovery was destined to play an important part in architecture. In fact, all styles may be divided into two classes, that of the lintel and that of the arch.

The Romans carried the development of this principle to a high degree of perfection, and the round arch became the essential feature of the early Roman construction.

When, at a later day, they conquered the Greeks, they transplanted Grecian architecture to Rome only to decorate their own arched construction.

Instead of the arch being used as a decorative feature of Roman work, it is the vital principle of construction, while the Greek orders were applied literally as appendages, very much as trophies of conquest were carried in their triumphal processions or displayed in their forums.

A Roman monument may be deprived of all its decoration and its apparent form removed without prejudice to its structure; as, in many cases, the Greek orders have been stripped from their buildings for the sake of the marble, and the real Roman construction stands forth in its native dignity, as may be seen in the three great arches of the Basilica of Constantine, the ruins of the baths of Caracalla and those of Diocletian, and in the better preserved walls and dome of the Pantheon.

The latter building, remaining to this day the largest dome of masonry in the world, is a good example of the Roman method of resisting the thrust of arches with great masses of inert material and not by active opposing forces, the walls of the Pantheon being twenty feet thick and the dome of great thickness of solid concrete, with ribs of brick.

The extensive use of small stones, brick and concrete in Roman work necessitated the use of mortar to fill the interstices and bond the whole together. In this material the Romans excelled all builders down to very modern times. (See Fig. 5.)

It may appear presumptuous to criticise the Roman combination of arched construction and the Grecian linteled orders, as such work is considered classic and is much copied in modern times. We shall see, however, that the next great change in architectural style, the introduction of the Romanesque, was not the result of Christian prejudice, but of Greek logic applied to building construction. When, in 330 A. D., Constantine established the seat of the Roman empire at Byzantium and undertook to erect monuments that should rival those of imperial Rome, he employed, for the purpose, Greek architects who had not been completely subjected to the dictations of their Roman masters, and who were allowed to exercise their mechanical knowledge and artistic tastes in erecting the required buildings.

These men, with logical minds, and having not only the benefit of experience with Roman work, but the actual materials taken from the many ruins of Roman work to build with, adopted a new combination, which, as we shall see, was purely structural. (See Fig. 6.)

The value of the arch, as developed and employed by the Romans, commended itself to the Greek mind as not only the simplest and most economical method of spanning openings, but the only practical method of covering large ones.

They saw, however, that when arches were used to carry the superincumbent weight, the entablature, the essential and most expensive part of the classic orders, was utterly useless, and they did not hesitate to discard it.

Taking the columns, which were brought from Rome, they set them up as the supporting members, and, adjusting capitals with stronger forms and larger abaci, they turned the Roman arches directly from the tops of such capitals, and by this simple mechanical device was given to the world the Byzantine or early Christian architecture, the progenitor of all Romanesque styles, quite as logical and mechanical in its way as was that of the early Greeks.

The example thus set in the East was soon followed in all parts of Europe. Even in Rome itself, the fallen entablature was allowed to lie dormant and in disgrace for nearly a thousand years.

Dispensing with the classic entablature was not the only suggestion given to the world by the Byzantine architects, for in their grandest monument, the church of Santa Sophia, we have the results of the first attempt, on a large scale, to resist the thrusts of domes and vaultings with counter-thrusts.

The church, as built under Constantine, doubtless had a wooden roof, and was destroyed by fire about 535 A.D.

Under Justinian it was rebuilt on a grander scale and with vaulted ceilings and stone dome 104 feet in diameter. The ambition of the architect Anthemius exceeded his scientific knowledge of the lateral thrust of such construction, although he planned very ingeniously to resist the thrust on the north and south sides by means of immense hollow buttresses extending across the side aisles to a distance of 90 feet, and on the east and west sides with half domes of the same diameter as the central one. These half domes were again buttressed by smaller half domes and lateral arches. Still the great dome had not been finished when it gave way on the east side and fell, carrying with it the half dome on that side.

After this disaster and the death of Anthemius, the superintendence of the work devolved on Isidorus of Miletus, who strengthened the piers, built buttresses against the east side, threw flying arches from the great side buttresses, and filled up the large arches on the north and south sides with small arches in three stories.

With these and other devices, and by using the lightest stone obtainable for the dome, Isidorus succeeded in finishing the building in such a manner that it has stood for over thirteen centuries and in more modern times has been copied many times on a smaller scale for Turkish mosques; and the appearance they present of an attempt to pile dome on dome is the simple result of buttressing the thrust of a large dome with several smaller ones.

As the expedients employed to overcome mechanical failures have often given new and acceptable forms to architecture, so unremedied failures have sometimes been applauded as great achievements. For example, I have often read in magazines and popular newspaper articles great praise bestowed on the builder of the Leaning Tower of Pisa, attributing to him a desire and ambition to erect a monument that should appear to challenge the very laws of nature and a marvelous degree of success in that direction, when, in fact, the slightest intelligent investigation will show that the tower was built vertically and commenced to settle to one side before the two upper stories were built. These again were built vertical, when further settlement threw them out of plumb, but, of course, to a less extent than the lower stories.

Notwithstanding its great inclination, the center of gravity is several feet within the supporting lines of the base, but it is not recorded that a laurel crown was conferred on the architect in recognition of his brilliant achievement.

It was by such failures, and many more disastrous ones, that the lesson of safe building, especially of equilibrium in arched and vaulted constructions, was learned.

During the eight centuries that Romanesque architecture prevailed, there was a growing desire and effort

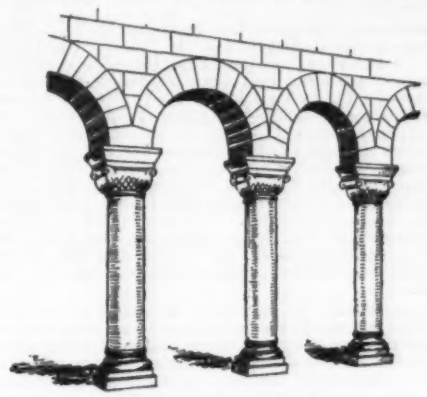


FIG. 6.—BYZANTINE.

to render churches and other structures fireproof by means of vaulted ceilings and roofs. These ceilings, arched with brick, stone, or concrete, often pushed out the massive walls and the building collapsed.

To prevent this, plain, square buttresses were built on the outside to assist the walls in resisting the thrust of the arches. These buttresses, often built after the defects manifested themselves, soon became conspicuous in the designs, and, therefore, a feature of the style.

As the ambition of the Church seemed to run to larger and higher edifices, the difficulties in resisting the thrust of these interior semicircular vaultings increased rapidly, and the skill and ingenuity of the builders were taxed severely to meet them.

Other difficulties arose in using the round arch with churches having different widths of nave and transepts and still different lateral openings. The arches could not be brought to a uniform height, the intersecting lines were awkward, and the general effect often unpleasant.

(To be continued.)

MOTOR VEHICLES FOR HEAVY LOADS.

THE illustration given on this page represents one of the latest vehicles constructed to carry heavy loads by the Steam Carriage and Wagon Company, of Chiswick, for Messrs. Fuller & Company, brewers, Chiswick. The engraving shows the lorry with the superstructure.

The engine is of the horizontal compound pattern, having cylinders 4 inches and 7 inches diameter by 5 inch stroke, and it is entirely closed in, the working parts running in an oil bath. The gearing is arranged with two speeds. The boiler, of the well-known Thornycroft type, has been slightly modified so as to give about 25 per cent. more heating surface than formerly, and the bottom plate has been altered somewhat to allow of its being more readily removed.

The body of the lorry has been designed to meet Messrs. Fuller's requirements, and is mounted on the channel steel under-frame. When desired, this can be quickly replaced by bodies of other type, thus rendering one motor part applicable to a variety of trade purposes—a point kept in view by the constructors in all their latest vehicles. The overall dimensions are: Length, 17 feet 4 inches; breadth, 6 feet 6 inches; and height, 9 feet 6 inches; the carrying body has a floor area of 65 square feet and a capacity of 12 cubic yards. It is designed to take a load of fifteen barrels (= 3¼ tons average), but the cubic capacity has been made large in order that the vehicle may, in the homeward journeys, bring back as nearly as possible a full load of "empties," and thus approximate to a condition of continuous full load running. The vehicle is designed to transport a maximum of five tons; of this, three are carried by the vehicle itself, and two on a trailing vehicle with open lorry platform.

The case in favor of steam-driven wagons is best when considerable loads have to be carried daily over comparatively long distances, and Messrs. Fuller employ the vehicle just in this way to supply their various depôts situated at distances of ten to twenty miles from their brewery. Sufficient water is carried for a full run of from fifteen to twenty miles, and enough Welsh coal for a long day's run; a slow-speed gear is fitted, enabling an extra tractive effort to be made on up gradients and on soft roads.

The vehicle can be driven by one man, but it is better that he should be accompanied by a lad. The steering wheel, reversing lever, regulating valve, by-pass, feed, and brake are easily manipulated by the driver when seated; the pressure and water gages, firing hole, etc., are also in full view in front of him, but without in any way obstructing his view ahead. Taking all items of expenditure into account, viz., interest, depreciation, wages, fuel, water, stores, repairs, housing, and insurance, the cost per half ton mile or ton mile of useful load is between 3½d. and 4d., and this, it is believed, will compare very favorably with figures similarly obtained with horse haulage.—We are indebted to London Engineer for the above information.

THE PURIFICATION OF ACETYLENE.

By P. WOLFF.

HARDLY a day passes without some new method for the purification of acetylene being proposed, with the object of preventing the formation of smoke, which always accompanies the combustion of this gas. This smoke is due to the polymerization of the acetylene itself; it can, therefore, only be prevented by using special burners, and not by further purifying an already sufficiently pure gas.

Ferric hydrate, Laming's mixture, or any other analogous product, can be used for absorbing the ammonia and the sulphureted hydrogen; but they do not absorb the phosphureted hydrogen, which really constitutes the only objectionable impurity. To absorb this gas, Lunge and Cedercreutz have proposed the use of chloride of lime, which plays the part of an oxidizing agent (Jour. Soc. Chem. Ind., 1897, p. 1046).

Now, previous experiments showed the author that the action of chloride of lime on acetylene is accompanied by small explosions following the formation of chloride of nitrogen at the expense of the chlorine of the chloride of lime and of the nitrogen of the ammonia, which is always to be found in acetylene. It is, therefore, necessary to free the acetylene of its ammonia before purifying it with chloride of lime. This can be thoroughly done by simply washing with water. Chloride of lime can absorb phosphide of hydrogen at the same time as the sulphydric gas without danger. Thus purified, acetylene possesses only a faint ethereal odor, which should, if possible, be accentuated for facilitating the detection of leaks. This can be effected by mixing with it a small quantity of carbylamine or acetate of amyl, or, again, by simply passing it over carbide of calcium. The act of drying by contact with this body causes the liberation of a small quantity of raw acetylene, which communicates sufficient smell without contaminating it to any appreciable extent.

Pure acetylene does not attack copper or its alloys, but any trace of impurities quickly causes brown stains to appear on polished bronze ornaments. These stains are formed of phosphide, and not acetylide, of copper. —Chemiker Zeitung, xxii., [28] p. 281.

STEAM MOTOR WAGON.

ENGINEERING NOTES.

The areas of the principal coal fields of the world have been estimated as follows: Great Britain, 9,000 square miles; United States of America, 194,000; Russia, 27,000; China and Japan, 200,000; Germany, 3,600; Belgium and Spain, 1,400; India, 35,000; France, 1,800.

According to the latest statistics, the Japanese mercantile marine comprises 735 vessels, of a total measurement of 390,334 register tons—570 of the number being steamers from 50 tons upward, measuring 363,233 tons, and 165 being sailers of 100 tons and upward, measuring 27,211 tons.

On some of the railroads crossing the prairie between Omaha and Denver, wooden fences have been replaced by iron posts, made from the tubes of old locomotives. The ends are filled with cement to prevent the interior from rusting, and holes are drilled at intervals to hold the wire. It is believed that a fence thus built will stand for ten years without need of repair.

It was stated at a recent meeting of the Falmouth Harbor Board that the Trinity House officials have agreed to place a gas-lighted automatic sound-producing buoy in the situation of the present bell buoy at the Manacles. The bell buoy was useless in easterly gales, and to add to the existing lights would lead only to confusion. The new buoy will not interfere with the present lights at St. Anthony and the Lizard. If possible, the Trinity Brethren will place the new buoy in position this summer.

La France Militaire states that the railway connecting the Senegal with the Niger is finished as far as Bufalabe and will soon reach Kita. A line in French Guinea, running from Konakra to Kurussa on the Niger, will shortly be begun, and preparations are nearly completed for constructing a line from Grand Bassam to Kong, through the valley of Bandama on the Ivory Coast. In Dahomy a line connecting Kotonu, Abomey, Carnotville, and Madecate, where it will reach the Niger, has been surveyed.

The use of the water-jet in pile-driving has long been known, but some Russian engineers have worked out a method of pile-driving which makes the pile sink three or four times more quickly than by the old method. Gas pipes lead down to the lower ends of the piles. At the top gutta percha pipes are attached, through which air under seventy-one pounds pressure is forced. This clears the way for the pile to be easily driven. When down far enough, the gas-pipe is lifted off and out, and attached by staples to the next pile.

The Central News learns that the construction of the railway from Acre to Damascus is now assured, although at one time there were fears that the project would fall through. Mr. Arnold F. Hills, of the Thames Iron Works, under contract with the railway company, has taken over the control of the enterprise. The work of construction has been resumed on a large, business-like scale, and it is expected that by the end of twelve months the first section of the line—that from Acre and Haifa to the River Jordan—will be open for public use.—Mechanical Engineer.

Two new coaling stations for the navy are soon to be ready for use by government vessels. The first one to be completed is situated at Dry Tortugas, Fla., and will have a capacity of 40,000 tons; this will be opened within a few weeks. A new channel has been dredged, and with the sheds on iron piers projecting far enough into the water to permit warships of the largest class to lie alongside and coal, this will become one of the most important naval stations on the Atlantic Coast. About $100,000 has already been expended, and a like sum will be spent for coal. The other station will be at New London, Conn., where about $150,000 is being expended to make this also an important coaling station. This station will not be ready for service before the coming fall.—Engineering News.

Road building in Porto Rico, under Maj. Francis L. Hills, M. Am. Soc. C. E., Director of Public Works at San Juan, is now employing about 15,000 men, according to that officer's last report to the Secretary of the Interior, says Engineering News. Maj. Hills, who is a graduate of West Point, and an ex-officer of the 3d Artillery, has thoroughly systematized his work, and at the date of his report, April 29, 62 roads were being rebuilt or repaired. The men are divided into gangs of 35, with a foreman to each gang, and superintendents over the section. The whole island has been divided into two roadbuilding districts, and the men are paid 50 centavos for 8 hours' work, with payments twice per month. The construction is intended to be permanent; the roads are carefully graded, ditched and macadamized; and the roads selected are those which will serve as main arteries for communication between the interior and the seacoast. During the month of April, 195,000 pesos was taken from customs receipts and expended on roads. Gen. Guy V. Henry, in leaving the department, wrote a letter to Maj. Hills thanking him for the important work done in road construction, and in the useful employment of large bodies of men.

It is interesting to read that the most powerful steamship in the world is in process of construction, to ply on a fresh water lake, in the interior of Asia. This fresh-water pond is Lake Baikal, in Siberia, and the steamboat is intended to transport across it the trains of the Trans-Siberian Railway. As the lake is frozen to a great depth in winter, it is necessary, to prevent suspension of the traffic in the coldest weather, to provide the steamer with means of breaking the ice in its course, and it is for this purpose equipped with engines of 40,000 horse power. A similar boat, but of much smaller size, is employed in the port of Cronstadt. This has engines of 12,000 horse power, and will make its way, at a speed of about two miles an hour, through ice five feet thick, so that the Baikal steamer, with engines of more than three times the power, seems to be calculated for anything short of Arctic weather. The force possessed by this mighty craft may be judged by comparing it with the largest of the North German Lloyd steamers, the "Kaiser Wilhelm der Grosse," which is claimed to be the most powerful vessel on the ocean, but has engines of only 28,000 horse power, while the great majority of ocean freight steamers are driven by less than 1,000.—American Architect.

ELECTRICAL NOTES.

During a recent thunderstorm, the Obercassel power house of the Düsseldorf-Crefeld light-railway was struck by lightning, with the result that traffic on the line had to be suspended for two hours. Further particulars of the occurrence are not to hand.

There are 569 miles of electric railways in Canada, exclusive of those in British Columbia. Statistics show that the train mileage run in 1896 was 21,917,151, and the number of passengers carried was 73,496,069. The total capital and bonded debt was £4,600,000. There were in use 947 motor cars, with 1,315 motors, 360 trailers, and 62 street sweepers and snow plows, while the total number of hands employed was about 3,400.

The Daily Mail Paris correspondent says that the chief authorities of the firemen in Paris have at length, after months of study and experiment, arrived at a satisfactory type of fire engine, of which the motor force is electricity. A new electric engine, capable of seating a dozen persons, and traveling at an average rate of 15 miles an hour, and ascending hills easily and stopping quickly, has been built, and will be in use from June 1.

Electric motor traction has been successfully tried, and will shortly be put into use by the fire brigade of Paris. An auto-car has been constructed to carry the escape ladders, cords, and other appliances, and eleven passengers. The vehicle is provided with an electric motor, the accumulators being placed underneath the body of the carriage in which stands the fire escape. When put through its trials the new car, fully equipped and conveying the engineer, the brigade officer, his orderly, and eight firemen, behaved very well, keeping up a speed of 15 miles an hour, and negotiating inclines without difficulty. The new motor car will be put into use at the headquarters of the Paris fire brigade. It is expected that all the stations of the city will be provided with similar vehicles in due course.

The application of electricity as a motive power is becoming general in Poland. It is being adopted not only for traction, but in a great many factories where electric motors are superseding rope and belt driving. Electric lighting of factories is becoming general, all new works being built with an electric plant, while old factories are abolishing the antiquated oil or gas lamps, replacing them by arc and incandescent electric lamps. On the Warsaw-Vienna Railway all important stations are being lit by electricity, and it has been decided to increase the plants in the near future. In the workshops of this company only electric motors are used. The Ivangorod-Dombrova Railway Company are also lighting all their stations by electricity. The competition in this branch is very keen, and, according to the local British consul, the Germans have succeeded in getting the lion's share, nearly all important works having their agents or representatives in Warsaw.

Till recently the employment of electricity in any shape or form in Constantinople was strictly forbidden. For an unfortunate official to mention the word "electricity" in the hearing of the Sultan was as much as his place, if not his head, was worth. Incredible as it may appear, his Serene Highness naively imagined that a dynamo must have something to do with the manufacture of dynamite. So much is there in a name. The final triumph over the prejudices of the Sultan is said to have been due to a Spaniard and the cinematograph. This Spaniard, Don Ramirez by name, started a circus in Constantinople, and in order to be up to date, imported a cinematograph. But the city authorities would not allow him to set his new instrument in operation, because it had to be driven by the condemned electricity. In his difficulty he applied to his ambassador, who promised to do his best for him. During the next audience which he had with the Sultan, the wily diplomatist took occasion to enlarge on the wonders of the cinematograph, and interested the Sultan so much that Don Ramirez was ordered to bring his instrument to the palace. Moving scenes from the leading capitals of Europe were thrown on the screen for the delectation of the Sultan, who no doubt enjoyed them all the more, since he is not, like his friend the German Kaiser, a great traveler. Among the indirect results of this exhibition was that the Sultan became convinced that electricity, though produced by a dynamo or a battery, had no connection with dangerous explosives; the lucky Don got kudos and wealth, and permission was granted to him to install in his circus the first electric lighting plant in Constantinople.—English Electrical Review.

Now, while Manila and the Philippines are so much to the front in connection with the war operations of the United States to reduce the Philippinos to subjection, it may be of some interest to know of the electrical state of the capital as left by the Spaniards. The central station is near the center of the city. The Pasig River, which runs through the city, divides the old from the new town, and the current is carried across the river by three bridges on steel poles, the lines being tapped to supply lights to each bridge. There are 450 steel and 1,400 wooden poles, and the lines are carried in oil-filled porcelain insulators. The Manila Electric Light Company have a contract to light the streets for twenty years, sixteen years of which are still to run. Gen. Otis has taken over the responsibilities of the contract and is paying the electric lighting bills for the streets. The original contract provided for one hundred and forty 2,000 candle-power arc lamps and one thousand 20 candle-power series incandescent lamps at $60,250 per year. The arcs are 50-volt lamps, twenty in series, on a 1,000-volt circuit. The number of street lights has greatly increased. On wide streets the steel poles are in the middle, and it is provided that the lights should be switched in twenty minutes after sunset and off twenty minutes before sunrise. There are about six thousand incandescent 16 candle-power lamps running on 100-volt alternating transformer circuits. The charge is $1.50 Mexican per month for a 16 candle-power lamp burning half the night, and $2 for an all-night lamp. The central station is equipped with six compound condensing engines of 300 H. P. each, ten alternating current generators, 2,000 volts of 60 kilowatts capacity each, and four 65-light 2,000 candle-power arc dynamos running at 3,250 volts. The capacity of the station is 12,000 incandescent lamps and 200 car lamps.

MISCELLANEOUS NOTES.

Dr. Playfair, the London physician who was condemned to pay $50,000 damages for libel a few years ago, was hurt in a queer automobile accident recently. He was going up a hill when something gave way and the carriage began to roll backward down the slope. The driver applied the power brake to the rear wheels, forgetting that he was going backward, with the result that the carriage stood up on end and tipped backward, bruising Dr. Playfair as it fell upon him.

The question concerning the liability of sleeping car companies for loss of money by passengers who purchase berths came up recently at the appellate term of the supreme court of New York. A passenger missed a sum of money after leaving the sleeper. In a suit he brought against the company in the city court he got judgment for the full amount. In the general term the judgment was reversed, on the theory that a sleeping car company is not the insurer of those who buy berths. The justice of the appellate term holds "that a sleeping car company is bound to use care in protecting the personal belongings of those whom it invites to occupy berths and that the jury had found in the case at bar that such care was not exercised. This liability, however, is limited to the money and other articles necessary for the traveler during his journey, and according to his station in life. A new trial is ordered."

There are four workshops engaged in making cardboard and pasteboard in Japan, with an average daily output of thirty to forty tons. In quality the home-made article bears comparison with the German or American make, but this remark cannot yet apply to the prices. Nevertheless, probably because of a very narrow margin of profit procurable, the import of foreign goods is practically stopped. An ingenious innovation, recently started by the Tokyo Card and Pasteboard Company, the largest in its line in Japan, has resulted in markedly facilitating the development of the industry. It consists, says The Japan Times, in making thick tarred pasteboards as substitute for shingles for ordinary roofing. The paper shingles are now in active demand, being about 50 per cent. cheaper and far more easily managed than ordinary shingles, hence considerably economizing the labor of mechanics. They do not differ much in point of being proof against fire and water compared with the ordinary articles.

Selenium has not hitherto played any very important part in commercial industries; it has been chiefly known in the chemist's laboratory as a curious and interesting substance possessing no specially useful properties. It has recently been employed in the glassmaker's pot for producing colored glass. Rose-tinted glass is made by adding selenium directly to the ingredients in the melting pot, the depth of tint depending entirely on the quality used, and also to some extent upon the character of the glass—whether it be hard or soft. A lovely orange-red color is produced by mixing cadmium sulphide with the selenium before adding to the contents of the pot. The intensity of the yellow constituent in this case depends directly upon the proportion of cadmium sulphide made use of. A practical advantage attending this process is that it is not necessary to reheat the articles after being manufactured and to dip them in a coloring mixture, as in the ordinary process of making red glass.—Pottery Gazette.

The house of a great hacienda is imposing in appearance, on account, usually, of its size rather than of its architectural proportions. It is generally built around a large court, and whether of one or two stories, conveys the impression of having been erected solely with a view to durability and spaciousness. The construction is invariably of stone or sun-baked bricks, plastered and painted, and in most cases presents an even elevation, broken only by grated windows, a porte-cochère and loop-holes for musketry. This structure contains the offices, apartments for the owner, for the two or three principal employés and their families and for the servants, store-rooms, stables for saddle and carriage horses, carriage space and an indefinite number of spare rooms, according to circumstances. Conveniently situated in relation to the main building are the habitations of employés, the huts of the peons, sometimes the posada or inn, for the accommodation of travelers, the church (which usually is a pretentious structure), the store, where every commodity of peasant life is for sale, the vast stables for horses, mules and oxen, storehouses for the produce of the hacienda, and others for agricultural implements, the wheelwright, blacksmith and carpenter plants, the saddler's and cobbler's shops, the loom, the bakery—in sum, all the attributes of a village, which a hacienda of this class is, practically, having a population of from 500 to 1,500 inhabitants.—Prince A. de Iturbide, in North American Review.

Blasting with high-pressure steam, instead of the usual inflammable explosives, is a proposition made recently by Mr. H. Schaw before the Institution of Mining Engineers of Great Britain, says Cassier's Magazine. Briefly, his suggestion, which has been prompted more particularly by accidents in coal mines from coal dust ignitions due to the use of the customary explosives, is that a cartridge of water, lodged in a shot-hole, should be converted into steam at a pressure of about 150 pounds per square inch by means of electricity of low tension, and the cartridge or boiler to be made of such strength that it would burst at about this pressure, when the force set at liberty would break down the coal. Mr. Schaw found by experiment that it would be easily possible to boil water by the heat produced by a current of electricity passing through a platinum wire similar to that used for firing mines immersed in water, and is of the opinion that at the moment when the boiler or cartridge bursts, the wire will fuse and the electric circuit will be broken, and no risk of ignition of fire damp or coal dust will remain from the heated wire. Under the supposition that the force developed by the water cartridge would be sufficient to break down the undercut coal in a mine, Mr. Schaw thinks that the practical working of the proposed method would present no great difficulties, and that it would be perfectly safe in any coal mine; and this is its only recommendation, for it certainly would be more expensive and troublesome than the usual methods of blasting.—Boston Transcript.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Trade in Prague.—The export from this district for the quarter ended March 31, 1898, slightly exceeded the export for the same quarter in the year 1899, the total values being $352,535 and $331,027·85, respectively. The imports into this district are not ascertainable, no statistics being kept here. Trade conditions are better than a year ago, a number of enterprises having been projected which will give employment to many more laborers, and offer opportunities to American manufacturers of machinery and electrical appliances to introduce their articles.

This market has evidently been entirely overlooked by American exporters, says U. S. Consul Hugo Donzelmann, of Prague. Our manufacturers who have entered the European market have generally established agencies in London, Paris and Berlin, and some few at Vienna. During the last few years there has existed in Bohemia, the greatest producing state in Austria, a bitter strife between the Czechish and German nationalities, which has resulted in a movement to boycott as much as possible the German tradesmen and manufacturers. As nearly all public enterprises and a great many private ones are under the control of the Czechs, it can readily be seen that German houses cannot efficiently promote American exports to this market. Our exporters should establish a sample warehouse here, or at least open an agency.

There is at present a great demand for electrical supplies in this district, a number of electric car lines having been projected. Agents from the United States should be sent here.

Slate is another article for which there is a market. It is produced in Bohemia in very small quantities and in two colors only—blue and green. It is used for roofing purposes, but the production does not nearly supply the demand. The slate used is in the form of rectangles and hexagons, the sizes being from 12 by 6 to 21 by 11 inches, and, so far, the demand has been principally supplied from England, some also coming from France, Germany, and Switzerland. The last two countries send school slates as well. The first four car loads of American slate were brought here a few days ago through the firm of Josef Umlanft & Company in Bodenbach, Bohemia. So far as this market is concerned, our exporters have shown a certain apathy, possibly the result of the immense development of our exports during the last two years. This very extension of our trade will cause increased activity on the part of foreign manufacturers, and our exporters should cover every field possible and establish themselves firmly. It is conceded on all sides that American articles are superior to others of like kind; and, once the people in foreign countries are accustomed to use them it will not be easy to introduce other goods, even though these may be a trifle cheaper.

It is well known that the wages paid in Bohemia are very small, especially in the linen factories and some of the branches of the glass industry. Labor unions are being formed, which have demanded an increase in pay. A recent strike at Nachod on the part of the linen weavers resulted in a riot, in which business houses were plundered. It was finally quelled by the military.

Shoe Trade in France.—In reply to inquiries by a Massachusetts board of trade, Consul Thackara writes from Havre, April 27, 1899:

The shoe manufacturers of the United States are undoubtedly enjoying the benefits of the great prosperity which is now reigning throughout our country; and many of the factories, at the present time, are probably working to their utmost capacity in filling their orders. But, from the articles which have appeared in the boot and shoe journals and from the testimony of several of the leading manufacturers, the output of American shoes has caught up with the annual home consumption, so that in nine months enough boots and shoes can be made to supply all the home demands. During the remaining three months, in order to keep the establishments running, surplus stocks must accumulate, which will have either to be thrown on the market at a ruinous price or outlets abroad must be found.

It appears to me that if our shoe manufacturers would send representatives to Europe who could speak French or German, or both, to study the economic conditions of the countries, to consult with the leading shoe dealers, to see for themselves what the consumer wants, the shapes most in vogue, and the character of the articles with which they would have to compete, they would undoubtedly be able to make business connections which would be the means of allowing them to dispose of the surplus products mentioned.

The great drawback to the introduction of American factory-made shoes will undoubtedly be the price; for they most certainly are better made and handsomer in appearance than those sold in France. If trade is established, manufacturers must be careful to fill their orders promptly and honestly; they must not send shoes with paper-filled soles, pasted joints, or which are imperfectly sewed; for these will only act as boomerangs. Our manufacturers must understand that the French are a people of taste and know what they want, and that anything that is not good enough for America will most assuredly not be received here. To give good material and honest workmanship must be the rule.

Comparatively few American factory-made shoes are imported into France, owing principally to the price. In Paris, they can be bought at the Bon Marché, the Louvre, the American Shoe Store, and the Maison Raoul and Bauer. But they are seldom on sale throughout the provinces. If an American shoe were made to suit the wants and desires of the people, it would certainly meet with a ready market, provided it could be sold as low as the domestic article. I have not been able to discover any prejudice against American-made shoes among the dealers of Havre. On the contrary, if the prices were low enough and the shoes were made to suit French tastes, they would soon be offered for sale.

Of the shoes which are imported into this country, the greater portion comes from Belgium and Austria. There are, however, large quantities of shoes made in France. The shoe factories are spread over the entire country, the principal centers being at Paris, Nancy, Fougères, Limoges, and Leancourt. According to the official custom house statistics, there were imported into France, for consumption, 121,996 pairs of shoes in 1896, 121,224 pairs in 1897, and 133,100 pairs in 1898, at an average price in 1898 of 7 francs ($1.35) per pair.

The prices of ready made shoes on sale in this city—that is to say, the retail prices—vary from as low as $1 per pair up to $4 per pair. The shoe which probably sells best is one at about $1.75 per pair retail. The demand for the higher priced ready-made shoes here, as in America, is gradually increasing. Many of those who formerly had their shoes made to order at high prices are now, for economical and other reasons, buying the ready-made article. The shoes at $1.75 per pair are machine-made calfskin articles, neat in appearance, with a peculiar square box toe, the style now greatly in vogue.

A letter which I have received from a well known importer of American shoe machinery in Paris says:

"Most of the best kinds of French footwear for men are sold wholesale at prices ranging from $2.12 to $2.70 per pair, and it is not possible to import a first-class American boot or shoe to compete at that price, although American-made shoes look better, and some of our customers copy the American styles."

He says that it costs 3 francs (58 cents) per pair to import an American shoe. In order that our manufacturers may judge whether or not his assertion in regard to the possibility of importing American shoes into France is accurate, I shall give a few figures and let them make their own deductions.

The present duty upon shoes imported into France from America is 2·50 francs per pair, or 48¼ cents. According to a statement of an official of La Compagnie Générale Transatlantique, by the new freight line which this company is about to inaugurate, the first steamer leaving here May 9 next, the rate of freight from New York to Havre will be greatly reduced; it will probably be about 15 francs ($2.89½) per ton of 1,000 kilogrammes (2,204 pounds). The cost per pair for freight and duty can thus be estimated. The French dealer will require a profit of not less than 30 per cent. Taking all these facts into consideration, it appears to me that we would not be in a position to compete with the cheaper grades of shoes sold on this market, but we could possibly establish a trade in the better kinds. I can not but repeat the advice given above, that it would be a wise plan for our shoe manufacturers to send a representative abroad in order to see for himself the trade conditions of the different large shoe centers of this and other European countries.

I am not able to give a detailed description of the best-selling shoe in this market, which would convey a correct idea of how the shoe is made, the kind of leather used, the style and shape, etc. But I am quite willing to purchase a pair of shoes which, in my judgment, would be a fair sample of the line of goods with which our manufacturers would have to compete and submit it to them.

In reply to the last question, "Would it, in your opinion, conduce to the prosperity of our city and its industry to have its manual translated into the language of your country?" I would say that a manual, to be of real service, should be printed in the language of the country to which it is to be sent. I am constantly in receipt of catalogues, reports, etc., printed in English. To me, and to a few of the merchants who speak our language, this literature may be interesting; but it is incomprehensible to those unfamiliar with the English tongue.

Consul Prickitt, of Rheims, writes to the same firm, April 24, 1899:

In regard to your specialty—men's shoes—it seems to me it would require great effort to introduce them in this part of France. In the first place, there is a tariff of 50 cents per pair, and then the French are prejudiced in favor of their own productions and must be convinced that it will benefit them to purchase a foreign article. This will require object lessons, and the only way in which these could be given would be to have salesmen, speaking this language, visit the merchants, exhibit samples, convince the dealers that it would be to their interest to buy, and take orders on the spot. The best place to commence would be at Paris, for there are many English and Americans there, while here almost the entire population is French.

During the eight months ending February, 1899, the entire exports of boots and shoes from the United States to France were valued at about $16,000. Any notable increase in this trade would be viewed with alarm, and would almost certainly lead to an increase in the tariff rate.

United States Rivets Wanted in England.—Consul Marshal Halstead, of Birmingham, writes:

A firm of merchants here doing an extensive trade in American nuts and bolts, wishes to make connection also with some reliable firm which manufactures good rivets, cold stamped. I will be glad to hear from some rivet-manufacturing concern.

Germany's Merchant Marine.—It is interesting to note this empire's eagerness to equal England as a mercantile and manufacturing state. This city, Chemnitz, hundreds of miles inland, organized last week a branch of what is known as the national union for increasing the fleet. In the industrial development that has assumed gigantic proportions in the last forty years, the mercantile marine has not only kept pace with internal progress, but has done much to increase its fields of operation. Germany's fleet is second only to that of England. In 1875, Germany's merchant marine numbered 4,062 ships with 1,068,000 registered tons net; in 1895, she had 3,665 ships with 1,554,000 tons; in 1898, 3,693 ships and 1,555,000 tons. While the number of ships is smaller, the number of tons, compared with 1875, has increased 50 per cent. The falling off is in sailing ships. In 1875, there were 4,303 with a capacity of 878,385 tons and 299 steamers with 189,998 tons; in 1885, there were 3,607 sailing ships with 880,345 tons and 650 steamers with 413,943 tons; in 1895, 2,622 sailing vessels with 660,856 tons and 1,043 steamers with 893,046 tons; in 1898, 2,522 sailing vessels with 585,571 tons and 1,171 steamships of 969,800 tons. In general, a steamer is thought to be able to carry three times as much as a sailing vessel of the same size. The falling off in sailing ships from 4,303 in 1875 to 2,522 in 1898 was more than made up for in the increase of steamers from 299 in 1875 to 1,171 in 1898. The regular crews numbered, in 1898, 42,428 men. The average was 5·7 men to a sailing ship and 24·3 to a steamer. German writers point with pride to the fact that whereas formerly a good many, if not quite all, of the big ships were built abroad, they are now built in German shipyards, by German mechanics, with German materials, etc. All that is now needed, they say, is a powerful fighting marine. The empire's interests are in every part of the world. These must be protected. Germany will probably give attention next to building a large and powerful fleet. J. C. MONAGHAN, Consul.

The Bicycle Trade in Canada.—From the tables of the trade and navigation of the Dominion of Canada for the year ended June 30, 1898, recently issued, may be gathered some data of interest to the manufacturers of bicycles in the United States. The total number of bicycles sold in Canada during the year is estimated at 50,000, of which 27,262 were imported from the United States and 46 from Great Britain. In addition to this large importation of complete machines, the value of bicycle parts imported was $279,752 (of which the United States furnished $271,175), which is held to represent 12,000 complete machines at $27 each. In round numbers, the total of imported bicycles sold, complete or in parts, was 40,000, averaging in cost $22.20, on which a duty of 30 per cent. was assessed and $179,259 collected, while on bicycle parts the duty collected was $83,534.

In 1897, the importation of completed bicycles was 24,558, or 2,750 less than in 1898. The average cost in 1897 was $32.40, against $22.20 in 1898; and the duty, per machine, $9.72, against $6.66. These figures show that as the American manufacturer decreases the cost, the demand increases.

During the year ended June 30, 1898, 18,617 bicycles were manufactured in Canada, of which only about 10,000 were sold at home. While the United States was encroaching on this market, Canadian manufacturers were reaching out for the trade in foreign countries, and sold 8,617 bicycles for $373,383, Australia taking 5,229, Germany 1,441, Great Britain 616, France 490, and the United States 307, as their largest customers.

The prices seem to have been varied for each country, as follows: Great Britain and Australia, about $46; France, about $41; United States, about $35; Germany, about $30.

The indications at this writing (May 10, 1899) point to the early organization of a trust among the bicycle manufacturers in Canada. Several wealthy capitalists of this city are interested, and it is thought that such an organization would result in closing the small factories and concentrating the manufacture at Hamilton and Toronto. The proposed capital is placed at $3,000,000, of which $2,000,000 is to be taken in preferred stock at 7 per cent.—James M. Shepard, United States Consul, Hamilton, Canada.

Trade with Turkey.—Consul-General Dickinson, of Constantinople, under the date of April 7, 1899, writes:

It may interest American manufacturers to know that the latest steamer of the new steamship line between New York and Constantinople brought three locomotives to Alexandria for the railway through the Soudan. The effort to extend American commerce in Turkey is assuming such proportions that not only the newspapers of this region, but those of England, Germany, and Austria, are sharply calling the attention of their readers to the fact that a new and dangerous commercial rival has entered this field. The high quality of American goods and the ingenuity and enterprise of American manufacturers and exporters are thoroughly appreciated in all European countries, and the result of a direct steamship service which will enable American products to enter these markets on nearly equal terms with their European rivals is readily foreseen. The consul-general translates from a Vienna journal an article in regard to the United States competition in Eastern markets, the substance of which was sent by a correspondent to The London Times and was published in advance sheets No. 407 (April 22, 1899). Mr. Dickinson adds: One of the results of this movement is great activity on the part of merchants and brokers to secure the agency for American goods. American exporters should be informed that the selection of an agent to represent them in this region should be made with the greatest care. The agents should not only be responsible and honest, but they should not be engaged in other business which would lead them to give a preference to foreign products. Arrangements are now being made with parties in this city of unquestioned responsibility and character, to open a warehouse for the exclusive sale of American products, and the contracts already made provide that every effort shall be made, by advertising and otherwise, to introduce our manufactures and products throughout this region.

French Trade with Cuba and Puerto Rico.—Consul Jackson, of La Rochelle, under date of April 1, 1899, writes:

I have been asked to request the department to publish in Consular Reports that several exporting houses in this region desire to learn names and addresses of business houses in Cuba and Puerto Rico which purchase French goods, and the sort of goods. Information should be sent to this office.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 443. June 5.—*Trade in Prague—*Shoe Trade in France.

No. 444. June 6.—Trades Combination Movement in Great Britain.

No. 445. June 7.—Shoe Trade in Colombia—*Peruvian Trade and the United States Tariff.

No. 446. June 8.—Special Taxation for Department Stores in Germany—Shoe Trade in Ecuador—Shoe Trade in British Guiana.

No. 447. June 9.—Treatment of Wines in France—Gold Mining in Alaska: Notes from the Klondyke.

No. 448. June 10.—New Laws in Japan—Japanese Civil Service Regulations—The Bicycle Trade in Canada—Mica Fields in China.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

A SEISMOLOGICAL OBSERVATORY AND ITS OBJECTS.

By JOHN MILNE, in Nature.

TEN years ago seismologists practically confined their attention to the movements of the ground which could be felt. In Italy and Japan, where these were frequent and sometimes violent, they attracted serious attention; while in Britain, where earth tremors were comparatively unknown, any suggestion that this country should establish a seismological observatory might only have cast doubts upon the mental balance of its author. At that time it was popularly supposed that in our islands earthquakes were of such rare occurrence that a special establishment for seismological investigations was unnecessary. Seismology, however, like several other sciences, has in a comparatively short period advanced with strides, and now stands as foster-mother not only to a Romulus and Remus, but also to a number of other children all filled with promise.

Now we know that in England, or in any other non-seismic region on the surface of the globe, at least seventy unfelt earthquakes, each of which have durations varying between twenty minutes and several hours, may be recorded yearly. The probability is that these movements are transmitted from their origins as compressional and distortional vibrations through our globe, and the rate of transmission of the former is closely connected with the average depth of the path along which they have traveled. When our observations on these movements are more exact and numerous, we shall then know more than we do at present about certain physical characteristics of the planet on which we live.

At Utrecht, Potsdam and Wilhelmshaven, these unfelt movements frequently correspond in time with well-marked perturbations of magnetic needles; but inasmuch as similar needles are not disturbed at other stations, we are not quite certain that the observed irregularities in magnetograms are altogether the result of mechanical disturbance.

Then, again, we have the curious observation that at certain magnetic observatories prior to great earthquakes originating in their vicinity there have been uneasy movements in magnetic needles. When considering whether these observations are merely accidental coincidences, we must remember that the initial impulse or impulses of these disturbances have been sufficient to cause our world to palpitate from pole to pole, that they have sometimes been accompanied by bodily displacements of material sufficiently large to set the Pacific Ocean in a state of oscillation for many hours, and that the displaced material is in every probability highly charged with magnetite. We do not know the nature of the changes which were taking place in this material before its rupture, but we see in the final movement a possibility of sudden local magnetic disturbance. . . .

In Japan, built up as it is round a core of rocks saturated with magnetite, which in their deeper portions are intensely hot, and therefore probably possess a reduced magnetic susceptibility, these earth tremors are apparently, and as we should expect them to be, more pronounced than they are in England or Europe. As to whether the frétillements on the magnetograms from that country are more frequent and distinct than those taken under similar conditions in non-volcanic countries, I leave to be answered by those who have the means of making the necessary comparisons.

That the records from a seismological observatory throw light upon sudden movements of magnetic needles at certain observatories is an established fact; but whether the bond connecting magnetic observations and those obtained by the seismologist is closer than is usually admitted, is apparently a matter worthy of consideration.

From a series of seismograms obtained from different stations we should be in a position to locate the site of sub-oceanic changes, and determine positions to be avoided by the cable engineer. A single seismogram may often set our minds at rest as to the cause leading to cable interruption, a matter of special importance to isolated colonies, while it has repeatedly been the means of extending, confirming or disproving ordinary telegraphic information. Another class of observations to which the seismologist devotes his attention are those indicating secular, seasonal and irregular changes in the vertical, which are of importance to the astronomer, earth pulsations and a variety of instrumental movements, the cause of which is not yet clear. . . .

What is now required in Great Britain is not simply a central office where these records can be examined, but also a station at which a variety of seismological observations can be made which will be comparable with the records from corresponding instruments similarly installed in other localities. As illustrative of this, although it would be extremely interesting to note the varying effects of barometrical pressure upon the plains of Lincolnshire, and to compare the magnitude and period of earthquake waves as recorded there with those recorded on a rocky surface, it is extremely probable that the records of diurnal waves from such surfaces, or in fact from any two, but different alluvial or soft foundations, would only yield results of local value. Any haphazard selection of a site for a laboratory might take us to a place where we might find an apparent diurnal or other variation in gravity, and where the same gold bead upon an assayer's balance, rapidly changing its zero, might appear to have a different weight at different times. Then, again, if we wish to study the continuous trembling of our earth, we require to be on solid materials at least half a mile from a railway, and some distance from any source of artificially produced vibration. If in addition to this it should ever be found desirable to obtain a highly magnified record of the movements of a magnetic needle, it is obvious that we must be far removed from the possibility of electrical disturbance.

In Wyoming, a series of shales, belonging to the geological age known as the Cretaceous period, are worked at Rock Creek, Albany County. These contain a bed of clay of an unctuous feel, which changes in color on exposure to the atmosphere from greenish yellow to light cream. Many of the argillaceous rocks in our own country have a "soapy" feel; for example, the mineral steatite, or "soapstone."

THE CAVE OF PADIRAC.

THE Causses of the department of Lot (France) form with the Cevenol Causses a long belt of Jurassic limestone that stretches from east to west between the Cevennes Mountains and the Atlantic. The first named of these causses* are 1,150 feet in height, are more or less wooded, and are dotted here and there with picturesque villages. Among the latter is Padirac, which from total obscurity came into prominence a few years ago through the discovery in its vicinity of an abyss nearly 500 feet in depth. A thorough exploration of this curiosity of nature has revealed many wonders, the fame of which has attracted to the locality numerous scientists and sightseers, for whose benefit the interior of the abyss has been rendered easily accessible.

At about thirty yards from the mouth of the cave, there has been sunk a 45 foot shaft which pierces the vault of a subterranean gallery that extends along the wall. Upon descending this, the visitor perceives the abyss in all its grandeur.

Up above are seen shelves of rock that circumscribe a huge disk of azure, while from a terrace skillfully formed between heaven and earth, upon one of the points of this verdure-clad girdle of rocks, the eye takes in the bottom of the cave, and, through an optical illusion, imagines that it sees a flat floor, while in reality the 148-foot stairway through which a descent is effected ends upon a hillock around which winds a footpath that leads to the deepest part of the cave, and to the entrances of the subterranean passages.

THE 148-FOOT IRON STAIRWAY IN THE CAVE OF PADIRAC.

Perfectly protected from falling water, the tourist descends the 513 steps of the iron stairway without fatigue, and reaches the entrances to the subterranean galleries. Penetrating one of these, he comes to another stairway (this time of wood and of massive structure), and descending it, reaches the level of a river, which, for ages upon ages, has flowed limpid, glacial, and inviolate through the heart of the mountain. The tourist is now at 330 feet from the entrance. The abyss would be able to swallow the Pantheon like a cherry. But this is nothing; the true prodigy begins with the subterranean river, which may be followed for a distance of nearly 490 feet upon a wide and perfectly dry pathway. The light of the lamps shows the

THE SUBTERRANEAN RIVER.

* In Central France, the term "Causse" (from Calx, limestone) is applied to uncultivated plateaux of a calcareous nature.

tourist that he is advancing in a sort of cathedral nave with jagged walls. The vaults, which are from 30 to 45 feet in height, astound him. Continuing his journey, he finally reaches a wharf, which is rendered necessary by the fact that at the end of the 490 feet the river occupies the entire width of the passage, and, black, deep and slow, reminds one of the classical Styx. But the boat that awaits the tourist has nothing in common with Charon's sinister bark, for it is merry living beings and not pale ghosts that it carries for a quarter of a mile in this marvelous domain.

The vault now becomes wider and higher, and to the right and left are seen marble flowers, limestone lotuses, petrified mosses, stucco anemones, alabaster busts and antediluvian animals congealed in the ice of the poles. Such is the variety of forms assumed by the stalagmites and stalactites. Then comes the "Lake of Rain," the "Lake of Bouquets," the "Footprints of the Crocodile," the "Great Hanging Crystal," and, finally, the "Great Dome," a true subterranean basilica more than 300 feet in height and 325 feet in width, and with a suspended lake, a petrified cascade and a natural pulpit.

It is necessary to see the abyss in order to get an idea of it. Photography, so long as electric light is not at one's disposal, can give nothing but its details.

Padirac is located at a distance of six miles from Rocamadour, and at the same distance from Grannat. It can be easily reached from either of these railway stations. Carriages at a reasonable charge are at the disposal of tourists who wish to visit the abyss.

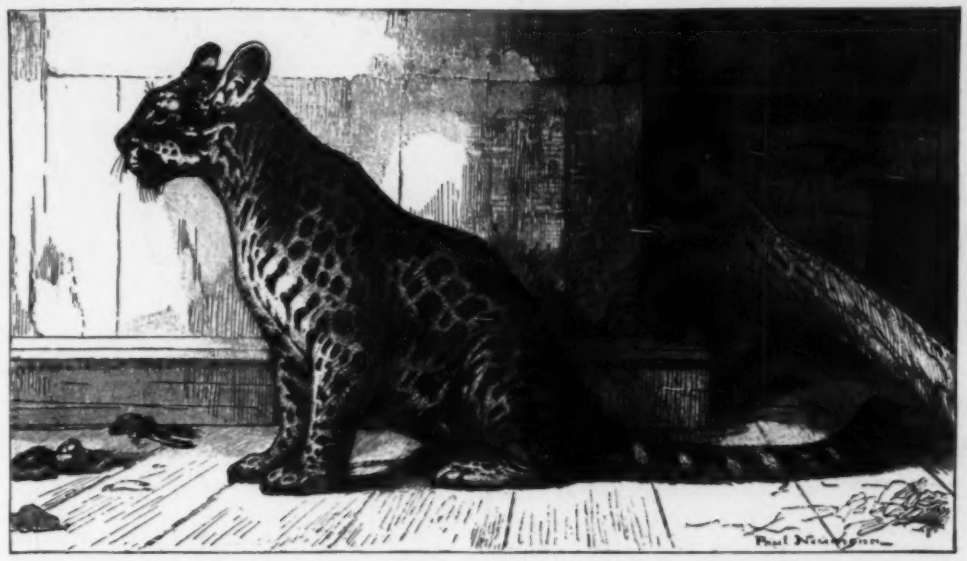
For the above particulars, and the illustrations, we are indebted to Le Monde Illustré.

CURIOUS EFFECT OF MENTAL SUGGESTION.

DR. E. C. SPITZKA, of New York, the noted alienist, has recently given several really remarkable instances of the power of mental suggestion. He cites the well-known fact that the mortality from wounds and diseases in a defeated army, compared with a victorious one, is as 4 to 3, and even as 3 to 2. It is also a fact beyond dispute that healthy, well-nourished people have been known to die apparently of starvation after being deprived of food for from three to five days. Dr. Spitzka is authority for the statement that these persons did not die of actual starvation, but from the psychical effect of hunger. This is shown by comparing their experience with the fact that persons (Zucci, Dr. Tanner, and others) have been known to fast voluntarily for more than forty days without serious results. Again, when the troops of William of Orange, besieged at Breda, suffered from scurvy, that prince fooled them with a harmless nostrum, and a large proportion of them recovered, the actual mortality being almost nil. Under the effect of the supposed remedy fear gave place to hope and faith, with the result stated. Examples might, indeed, be multiplied indefinitely, but one other still more remarkable than those already given will suffice. "In the graver forms of hysteria," says Dr. Spitzka, "when loss of sensation occurs in exactly one-half of the body, you can lay a piece of tinted paper on the sensitive side; then, suggesting it to be a mustard plaster, a red area will appear on the corresponding unsensitive side. Blisters of such a character that scars have permanently remained from them have been produced in similar cases by the same method." It is also a well-known fact that many persons have died at an hour previously named by themselves. On the same principle, many if not most persons dislike to make a will, fearing that their end will come the sooner for having disposed of their earthly belongings, and such has often been the case. It is quite possible that the extent to which this mental suggestion may be advantageously employed is not fully appreciated by the medical profession.

PUMA-LEOPARD IN THE ZOOLOGICAL GARDEN AT BERLIN.

THE animal shown in the accompanying engraving (for which we are indebted to the Illustrirte Zeitung) would be a puzzle to lovers of animals and even to those who can usually classify mammals, if they did not know his origin. The connoisseur would think



PUMA-LEOPARD IN THE BERLIN ZOOLOGICAL GARDEN.
DRAWN FROM LIFE BY PAUL NEUMANN.

first of the leopards found in the northern part of Asia, on account of the heavy, thick coat, and specially of the long, thick hair on the tail, but the ground color of the fur, which is dark brownish gray, is quite different from that of these Asiatic leopards. Upon closer examination, a remarkable combination and blending of the characteristics of the puma and leopard is apparent in this animal, which has the exact form of the puma, the low, heavy hind portion of the body and the small head with the roundish, muscle-shaped ears; but the blood of the leopard is shown in the peculiar marking, beautiful large brownish-red rosettes edged with black, which remind one of the ocelot. The spots on the head and legs are black and those near the root of the tail are brown, but these brown spots gradually change to rings running around the tail. These various characteristics produce a whole that is so new and strange that the visitors at the zoological garden who have seen nothing new among the animals of this species for a long time find our mongrel a great attraction.

The history of managerie and zoological gardens tells of many attempts to produce "specialties" by cross breeding between the jaguar and the black panther, the lion and the tiger, etc., but we have not heard before of crossing the puma and leopard. The sire of our puma-leopard, which was born in a small menagerie, was an Indian leopard and the dam a Brazilian puma.

FLEXIBLE FILMS FOR SPECTROSCOPIC PHOTOGRAPHY.

SIR Norman Lockyer has lately been experimenting, and very successfully, with flexible film, with the idea of adapting it to spectroscopic photography. The large concave Rowland grating which he is now using for his solar spectroscopic photographs has 20,000 lines to the inch ruled on its surface, and is of 21½ feet radius, giving a spectrum of 30 inches long. The focal plane of this grating is of necessity considerably curved, in fact the plane of accurate definition at the edges of the field is about half an inch in front of the similar plane at the center. It is, therefore, impossible to get a sharp photograph of the whole spectrum on a glass plate, in fact not more than 18 to 20 inches of the spectrum can be brought into focus on the same plane. This difficulty is, of course, got over by the use of a flexible film, which can be bent to the curvature of the field.

A print of one of Sir Norman's photographs, taken with this Rowland concave grating, showing the arc spectrum of iron with a comparison spectrum of the sun from wave length 3,600 to 5,200, is 30 inches long, and must be the longest solar spectrum photographed at a single operation. Sir Norman Lockyer also hopes that by using films, instead of glass plates, at the next solar eclipse, he will be able to obtain an increased number of photographs, owing to the rapidity with

THE INTERIOR OF THE GREAT DOME.

which the film can be shifted in the short space of time available for photographic operations. At the last eclipse the photographic work was concentrated on obtaining a series of photographs of the chromosphere both about the time of beginning and end of totality. By careful drill Mr. Fowler and Dr. W. J. S. Lockyer were both able to secure ten photographs at each of these important periods, the time occupied in making each series of ten exposures being 12 seconds. An apparatus for carrying films is also being designed which can be adapted to the spectroscopic cameras at present in use in the laboratory and observatory.—Journal of the Society of Arts.

THE FOREST TENT CATERPILLAR.*

By CLARENCE M. WEED.

DURING the last three years, in many parts of New Hampshire and neighboring States, there has been a serious outbreak of the insect which has long been known as the forest tent caterpillar, although in most regions where it has recently been present it is called the forest worm. It has attacked forest, orchard, and shade trees, and has done a great deal of damage in many regions of New England.

This is no new pest; for a century or more it has been known as a destructive insect. At frequent intervals in the past it has ravaged orchards and woodlands in widely separated States; from Maine to Texas severe attacks by it have been recorded.

These forest tent caterpillars hatch from eggs which are deposited in cylindrical masses that form complete circles upon the smaller twigs of a considerable variety of trees. The appearance of these "caterpillar belts" is shown in Fig. 2; the eggs are covered with a brittle substance which gives the mass a shiny appearance, especially in a bright light.

The young caterpillars or larvæ come forth from the egg in the spring about the time the leaves of the trees begin to unfold. When first hatched they are tiny creatures, scarcely one-tenth of an inch long, showing under a lens that the blackish body is provided with a covering of long brownish or grayish hairs. Wherever they go these little larvæ spin a silken thread which marks their pathway, although the thread is so slender that it is generally to be seen only through a lens.

The tiny caterpillars feed upon the tender leaves of the twig near where the egg mass was placed. In about two weeks each larva increases in size to such an extent that the skin in which it came from the egg is too small for it. This skin then splits open along the back, and the caterpillar crawls out clad in a new skin that had gradually been forming beneath the old one. This skin-shedding process is called moulting; it is the general way in which insects provide for increase in size. All sorts of caterpillars as well as other insects moult as they grow.

After the first moult the forest caterpillars begin feeding again, eating of course more and more of the foliage as they become larger. A week or so later they again moult, a process which is twice repeated thereafter at similar intervals. At the period of moulting the caterpillars are in the habit of congregating upon the trunks or larger limbs of the tree, often not far from the ground. Beneath the mass of larvæ there is an inconspicuous web in which the feet are more or less entangled. The appearance of the caterpillars at such times is well shown in the photograph reproduced in Fig. 3, for the use of which I am indebted to Dr. F. W. Russell, Winchendon, Mass.

When the caterpillars become full grown in this, their larval state, each seeks a place in which to spin

FIG. 1.—THE FOREST TENT CATERPILLAR.

its cocoon. Many remain in the trees and tie up the leaves by silken threads, thus forming a partial or complete covering for the cocoon (Fig. 4). Others seek crevices in the rough bark, while many others—probably one-half or more of all the caterpillars—forsake the tree and wander off in all directions, utilizing any shelter they may come upon. They commonly crawl up the sides of houses and other buildings, and form their cocoons along the clapboards or beneath the gables.

The cocoon is made of silk with an outer mass very loosely spun, and an inner mass so much more closely woven that it forms a web of almost parchment-like texture. As in the case of the American tent caterpillar, the threads of the cocoon are white when first spun, but become yellow by being saturated with a liquid which the caterpillar ejects shortly before pupation. As this liquid dries it leaves a yellow powder in the silk.

Soon after forming the cocoon around itself the caterpillar changes to the pupa or chrysalis condition, becoming an oval brown object without legs or wings, able to move only by a wriggling of its body. In this condition it takes no food, but within the quiet exterior the body of the caterpillar is being developed into that of a moth.

About ten days after the cocoon was made the pupa skin cracks open, and a brownish moth emerges from

FIG. 2.—EGG MASSES.

the cocoon; this is the adult condition of the forest caterpillar. The male moths are slightly smaller than the females.

The moths generally make their appearance the latter part of June. Soon afterward the females deposit their eggs in masses of about two hundred each upon the twigs. The moths, having completed the cycle of life, die soon after the eggs are laid.

The eggs thus deposited early in July are to remain unhatched until the following spring. The actual formation of the tiny caterpillars from the contents of the egg takes place, however, within a few weeks after they are laid. The minute but fully-formed caterpillars may be found within the egg shells, by a careful examination, any time between September and the following April. The caterpillars remain during this long period quietly confined within their narrow houses, but when the warm rays of the spring sunshine penetrate their abodes, they eat off the tops of the egg shells, and come out ready to break their long fast upon the tender foliage of the unfolding buds.

HABITS OF THE CATERPILLARS.

The caterpillars very commonly emerge from the eggs some time before the leaves of their food-plants push out. Under such conditions the tiny larvæ are likely to huddle together upon or near the egg mass to await the unfolding of the leaves. There seems to be considerable variation in the time of hatching, as larvæ of various sizes may be found at any time during the latter part of May or in June.

When the attack is not severe, the caterpillars seem to keep to the upper parts of the tree, especially upon the ends of the outer branches.

In this instance the damage had evidently been done before the presence of the insect was known. Consequently, it seems worth while for the owners of maple or other groves to keep a sharp watch upon their trees this season, even if heretofore they have not been injured.

When the caterpillars are disturbed while feeding upon the leaves or crawling along the twigs they have a habit of dropping downward, checking the fall by means of a thread spun from the mouth and attached to the twig. Thus suspended in mid-air they are very annoying to foot passengers in villages or to people riding along shaded roads in town or country; for to find yourself suddenly confronted by a dozen caterpillars on the level of your face is disconcerting.

According to some observations made by my assistant, Mr. W. F. Fiske, to whom I am indebted for a number of observations upon this insect, the young caterpillars if suddenly disturbed while feeding will drop to the ground without attaching their threads. A large proportion of the caterpillars drop off by means of a thread at one time or another during their growth; some are probably startled by the swaying of the twig in the wind; others by birds when alighting; in many cases the movement is probably induced by the exhaustion of the food supply, or, perhaps, by a migratory instinct. In any event, this dropping is very general, and as a result the caterpillars are continually to be seen crawling up the trunks of the trees. This is especially likely to be the case early in the morning.

The larvæ generally crawl along the limbs in single file. As they go, each spins from its mouth a delicate silken thread. When not eating, they congregate in masses upon the larger limbs, with an indistinct web beneath them, although generally there is no web over them, as is the case with the American tent caterpillar.

In feeding, especially as they approach maturity, the caterpillars commonly eat through the leaf in such a way that the outer end drops to the ground. The result is that in the case of the badly-infested trees the ground beneath is covered with these leaf fragments, which may be heard falling continually as the caterpillars work. This habit causes the insect to be relatively much more destructive than if it simply devoured the whole leaf because the tree is robbed of more of its leaf-surface, the damage done being somewhat analogous to that of the cutworms, which eat off the stem of a corn plant without devouring the leaves.

During the moulting periods, as well as during long-continued storms, the caterpillars collect together in great masses, resting upon a silken web attached to the bark of the tree. (Fig. 3.) Here they remain a day or two, until the old skins are sloughed off and the new ones are ready for use.

The caterpillar of this species is at once distinguished from the common American tent caterpillar by the differences in the markings of the line along the middle of the back. In the forest tent caterpillar this line is interrupted, consisting of a series of white markings, while in the common tent caterpillar the line along the middle of the back is continuous.

The two species of caterpillars may frequently be found intermingled. Sometimes a brood of the forest species will collect upon the outside of the tent of the common species.

When an orchard or grove in which the caterpillars have developed is defoliated, they will migrate to neighboring trees in a way suggestive of the migrations of the army worm.

At such times they may be seen in incredible numbers. Several cases are on record where in crossing railway tracks they have impeded the progress of trains by making the rails slippery as the bodies were crushed.

Those forest caterpillars which utilize leaves in forming their cocoons seem to have very little choice as to the leaves employed.

Evidently the larvæ utilize whatever foliage they find available when the stress of cocoon making is upon them. A correspondent at Haverhill, New Hampshire, reported that she found "pine trees covered with the cocoons of the forest tent caterpillar. The needles were tied together with their silk, and the cocoons inside of them." These leaf coverings are of all degrees of perfection, from such a well-knit specimen as shown in Fig. 4 to that of a cocoon in which two or three grass blades serve little more purpose than that of supporting the silken woof of the cocoon. Two or more cocoons are commonly spun within a single leaf, and trees frequently appear "bunched up" from the action of the caterpillars. Numerous observations indicate that normally about as many caterpillars spin cocoons in leaves as out, but the proportion would be likely to vary with the conditions present in a given locality.

HABITS OF THE MOTHS.

Like most moths the adults of these forest caterpillars are night-fliers rather than day-fliers. They are attracted by light after dark, and frequently fly through open windows into houses. Late in the afternoon they may also be seen, when abundant, flying among the branches of the trees.

ABUNDANCE AND INJURIES.

The injuries caused by these caterpillars have been serious and widespread. In many regions they have defoliated the maples of sugar groves. In some cases the trees have been killed, while in others their vitality has

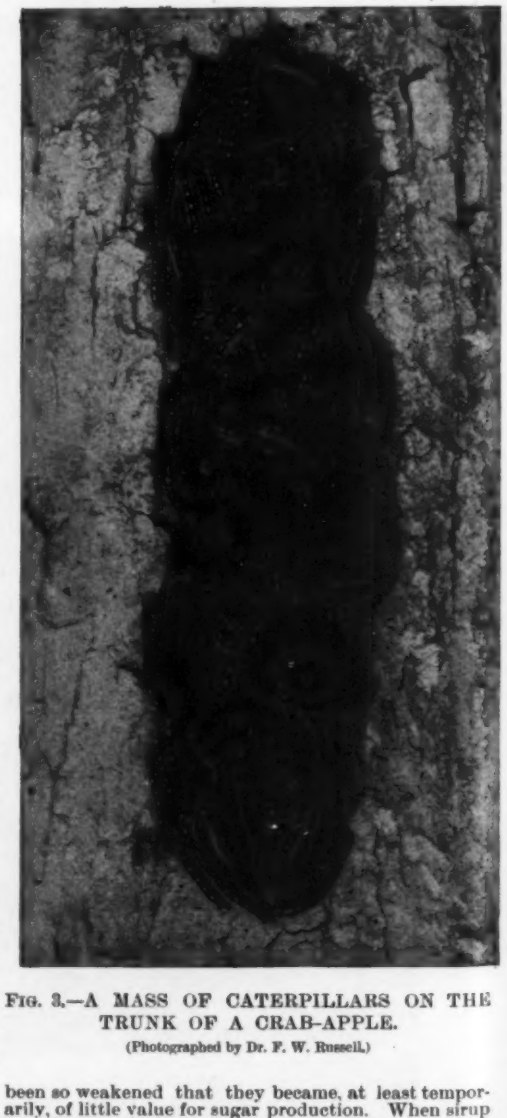


FIG. 3.—A MASS OF CATERPILLARS ON THE TRUNK OF A CRAB-APPLE.

(Photographed by Dr. F. W. Russell.)

been so weakened that they became, at least temporarily, of little value for sugar production. When sirup is made from such trees, it is of such inferior quality that it is often locally called "buggy sirup." All through the infested regions hillsides may be seen in which the woods are brown and bare from the attacks of the caterpillars. It is difficult for one who has not seen an outbreak of such a pest as the forest caterpillar to get an adequate conception of the enormous numbers which may be present. They have been collected, quarts at a time, in many localities, and are often so

* Bulletin No. 64, New Hampshire College Agricultural Experiment Station, Durham. Reproduced by permission.

abundant on the trunks of trees as to conceal the bark from view.

The effect of a sudden onslaught of an army of these caterpillars migrating from a neighboring woodland to an apple orchard may be disastrous. Defoliation may take place in so short a time that the leaves are gone before the presence of the caterpillars is known. In many cases a new crop of leaves will be put out, but the vitality of the trees is necessarily impaired.

DATES OF TRANSFORMATIONS.

The statement has already been made that there is considerable variation in the time of hatching of the caterpillars. By the middle of June, when some of the larvæ had become full-grown and spun cocoons, others had only moulted once, and many others only twice. The majority of the caterpillars spun up by June 25, and practically all by the 30th of the same month. Many of these caterpillars which spun latest were much smaller than the normal size. The earliest moths emerged about June 24.

NATURAL ENEMIES.

These forest tent caterpillars are preyed upon by many natural enemies, including insects, spiders, toads, and birds. Among the more important insect enemies are certain ichneumon flies, which deposit eggs within the bodies of the caterpillars. These eggs hatch into grubs that develop at the expense of the caterpillars, finally killing them. There are various other insect enemies.

A curious habit of a common species of harvest spi-

FIG. 4.—COCOON OF FOREST TENT CATERPILLAR IN A MAPLE LEAF. Natural size.

der or daddy-long-legs was observed by Miss Soule. On June 18 she wrote: "On almost every mat of Clisiocampa larvæ we find several 'daddy-long-legs,' sometimes as many as twenty. I have watched them closely and can see no reason for their being there." A week later she wrote again: "It seems this morning as if almost every larva was attended by a 'harvester,' which apparently stroked it with a leg or two or merely stood near or over it. Sometimes the touch made the larva curl up, but more often it seemed to have no effect. It is very curious, and I watch and watch, but can learn nothing." The species concerned seemed to be the common striped harvest spider,* as I judged from some half-grown specimens sent by Miss Soule. As to the reason for their presence, I can only conjecture that they found food in connection with the caterpillars in some way.

Toads were seen to devour many of the caterpillars, although, of course, these creatures are comparatively so rare that they could make little impression upon the pests.

Birds, however, did a great deal toward reducing the

FIG. 5.—THE CHIPPING SPARROW.

numbers of the insects. Miss Soule observed robins, orioles, chipping sparrows, cat birds, cuckoos, the red-eyed, white-eyed, and warbling vireos, cedar birds, and nuthatches, feeding upon the caterpillars. The nuthatches, according to Miss Soule's account, "would stand by a patch of larvæ lying close together below a tar band on a tree and eat so voraciously and with such an entire abandonment of self-consciousness that I could go close and put my hand on them before they would fly. This experience was repeated several times." The cocoons were attacked by chickadees, which tore open the cocoons and fed upon the pupæ, as well as by nuthatches. The moths were also eaten in great numbers by many sorts of birds, including robins, chipping sparrows, yellow birds, and even English sparrows, although this last named species apparently did not eat the caterpillars.

In some localities the forest tent caterpillars were attacked by what appeared to be a bacterial disease similar to the one which destroyed so many of the American tent caterpillars in southern New Hampshire in the summer of 1898. (See Bulletin 59, p. 202.) It is to be hoped that the present season it may complete its work, for this is probably the agency that is most likely to check the outbreak. Its destructive effect is likely to be increased by weakness in the caterpillars, due to the partial exhaustion of the food supply. There was also evidence that a fungus disease called "muscardine" was at work among them.

* Litbunum dorsatum.

REMEDIAL MEASURES.

Many remedial measures have been proposed at various times to prevent the injuries of the forest tent caterpillar. The practical value of most of these measures depends largely upon the conditions under which they are to be applied. A suggestion that is easily applicable to a few small trees in an apple orchard may be wholly inapplicable to the large trees in a woodland.

The abundance of the caterpillars, the nature and number of the trees infested, the season of the year, and the means at hand are all to be taken into consideration. In the following paragraphs I have summarized the measures which a careful study of the subject leads me to think will prove of value. They are arranged according to stage of growth—from egg to moth—to which they are to be applied.

Egg Destruction.—On a bright day, when the trees are bare of leaves, the egg masses may be easily seen. The cutting off and burning of these masses is often practicable in a young apple orchard, although it is generally considered impracticable in orchards of large trees. It generally would be out of the question in woodlands, of course, although in case of a few ornamental maples or other trees on the home grounds such egg collecting might well be worth while. The gathering may be done by sending a sharp-eyed boy into the trees to cut off the glistening masses, or by means of a pruning hook or a pair of long-handled pruning shears. The belts of eggs should be burned after they are gathered.

Killing the Young Caterpillars.—On small trees, where the caterpillars are easily reached, something may be accomplished by swabbing the colonies of young larvæ when at rest by means of a bunch of cotton waste, old rags, or something similar. In rainy weather one is more likely to find the larvæ massed together during the day than in bright weather.

Spraying with Poisons.—For the apple orchards, so far as concerns the caterpillars which hatch there, perhaps the simplest way of destroying these pests is to spray the trees with arsenites early in the season before the caterpillars are half grown. After the leaves are unfolded and the caterpillars have begun work, the earlier this spraying is done the better, except that it should not take place when the trees are in bloom. The common practice in spraying is to add four or five ounces of Paris green and a pint or two of fresh lime water—made by slaking lime in water—to a barrel holding forty or fifty gallons of water. This is thoroughly mixed and sprayed upon the trees by means of a force pump and spray nozzle. In Fig. 6 a simple and effective spraying outfit is represented. It consists of a kerosene barrel holding fifty gallons, a force pump having a double discharge, with a short line of hose running into the barrel to keep the liquid stirred, and a long line of hose fitted at the end to a slender brass rod tipped with a spray nozzle. This outfit, or a great variety of similar ones, may be obtained through any hardware dealer or direct from any of the numerous manufacturers of spraying machinery.

In case it is desired to spray trees of many sorts, it would probably be safer to use arsenate of lead, which is less liable to injure foliage than Paris green. This substance has been used in great quantities by the Massachusetts Gypsy Moth Commission. It has been found a safe insecticide for all sorts of trees. It is not generally on sale in the market, but can be made according to the following directions of Prof. C. H. Fernald:

"Arsenate of lead is easily prepared by putting 11 ounces of acetate of lead in 4 quarts of water in a wooden (not metal) pail and 4 ounces of arsenate of soda (50 per cent.) in 2 quarts of water in another wooden pail, and, when entirely dissolved, mixing them in a hogshead containing 150 gallons of water, when a chemical reaction will take place, forming arsenate of lead as a fine white powder in suspension in the water. If cold water be used in the wooden pails, the solution of the acetate of lead will require a little time; but, however, if the water be hot, it will dissolve very quickly. It is customary to add from 2 to 4 quarts of glucose to the above amount of water. If it is desired to use larger proportions of the arsenate of lead, it is only necessary to use more acetate of lead and arsenate of soda, but in the proportions given above."

Another substance which has lately been put upon the market as a substitute for Paris green is called green arsenite. It is a finer powder than Paris green and generally costs at retail 15 cents a pound. It can be purchased of dealers generally, or direct of the manufacturers, the Adler Color and Chemical Company, New York. One great advantage it has over Paris green is that being a finer powder it remains in suspension much longer. A little lime water should be added to the mixture as in the case of Paris green. It is to be used at the rate of four or five ounces to fifty gallons of water.

Killing the Older Caterpillars.—After the caterpillars are half grown they commonly come down to the lower branches or the trunk to undergo the moulting process. To this end they gather in great masses on the bark, where they may be destroyed by means of a stiff broom—more effective, perhaps, if frequently dipped in kerosene—or by collecting the caterpillars in pails containing a little kerosene and water. In the towns and villages throughout the infested regions vast numbers of the pests were destroyed in these ways, especially the latter, in 1898.

Banding.—The fact that so large a proportion of the caterpillars drop off the trees from time to time and return by crawling up the trunks has led to the quite general use of bands of various materials upon the trunk to prevent the ascent of the larvæ. Tar has been quite generally applied for this purpose, but it is objectionable, as it does not remain effective long, so that the caterpillars are soon able to cross over it. Sticky fly-paper—"Tanglefoot"—has been commonly used with a large degree of success; it is effective, cheap, and easily applied. Rather wide bands of it are necessary to prevent bridging over by the dead or dying caterpillars. The chief difficulty with this paper is its liability to injury by rain, the wetness causing it to tear so readily that it may not last long. In some cases bands of greased tin have been successfully employed.

A better substance than any of these, however, is Raupenleim, or "caterpillar lime," a material manufactured in Germany for application to the bark of trees to prevent the ascent of caterpillars and other crawling insects. It is to be put on as a rather wide band, or as two narrower bands. In the case of large trees with thick bark the material may be smeared directly upon the bark, while in the case of young trees and those with smooth bark it is safer to apply the Raupenleim by smearing it upon a band of heavy wrapping paper or some other thick and firm paper tacked upon the tree. Any loose bark may be scraped off the portion of the trunk which is to be covered by the paper before the latter is put on; and it is sometimes worth while to insert a thin layer of cotton waste, or some similar material, beneath the paper to fill up crevices and thus prevent any insect from crawling through beneath the paper. Then the Raupenleim may be smeared upon the paper the thickness of about a quarter of an inch, and left as long as it remains sufficiently sticky to entrap any insect that attempts to crawl over it. As it will remain eight or ten weeks in a sticky condition, a single application early in the season will probably last until danger from the caterpillars is past.

It should be distinctly understood that there may be danger of injuring trees with smooth and thin bark if this Raupenleim is smeared directly upon the bark. For young trees and those older which have a smooth bark I recommend that the Raupenleim be applied by placing it upon strips of thick paper tacked to the trunks of the trees. Even in the case of bearing apple trees this would probably be the safer method, and it should always be adopted for peach trees if not for pear trees also. After the Raupenleim has been on

FIG. 6.—SPRAYING OUTFIT.

some weeks the surface hardens into a crust, and it is advisable to scrape off this crust after the danger from caterpillars is past. Too much of the rough bark should not be scraped off of the older trees to which the band of Raupenleim is to be applied, unless paper is to be used.

After the trees are thus banded, the caterpillars will collect beneath the bands, and, of course, are to be killed by means of a stiff broom, or any other method one may choose.

The American distributers of Raupenleim are William Menzel & Company, 64 Broad Street, New York, N. Y. In New England it can be purchased through the Bowker Fertilizer Company, Boston, Mass., and probably other dealers. It is put up in five pound cans, costing about $1 per can; or in kegs holding twenty-five pounds, costing $3.75 per keg. Larger kegs are proportionately cheaper.

Jarring and Banding.—It has already been stated that these caterpillars drop downward when disturbed, breaking the fall by means of a thread spun from the mouth; although when young and suddenly jarred apparently the thread may not be used. This habit leads to the suggestion that by a combination of jarring and banding much injury may be prevented, at least in the apple orchard and on the home grounds. After the trees infested have been banded with the caterpillar lime, a boy with a padded mallet may be sent into them with instructions to jar the limbs on which the caterpillars are working, beginning at the top. This should be done when the caterpillars are feeding upon the leaves as they are then much more easily disturbed than when they are at rest. Of course it is not to be expected that going over once will wholly rid the tree.

but by two or three repetitions of the jarring most of the caterpillars should be removed. In case they hang too persistently by their threads, many of them may be swept out of the air by use of a long, light pole. This will lead the caterpillars to congregate in masses upon the trunk below the bands of Raupenleim, where they may be destroyed by use of a stiff broom or by various other methods. The earlier this is done after the larvæ are all hatched, the less will be the injury to the foliage.

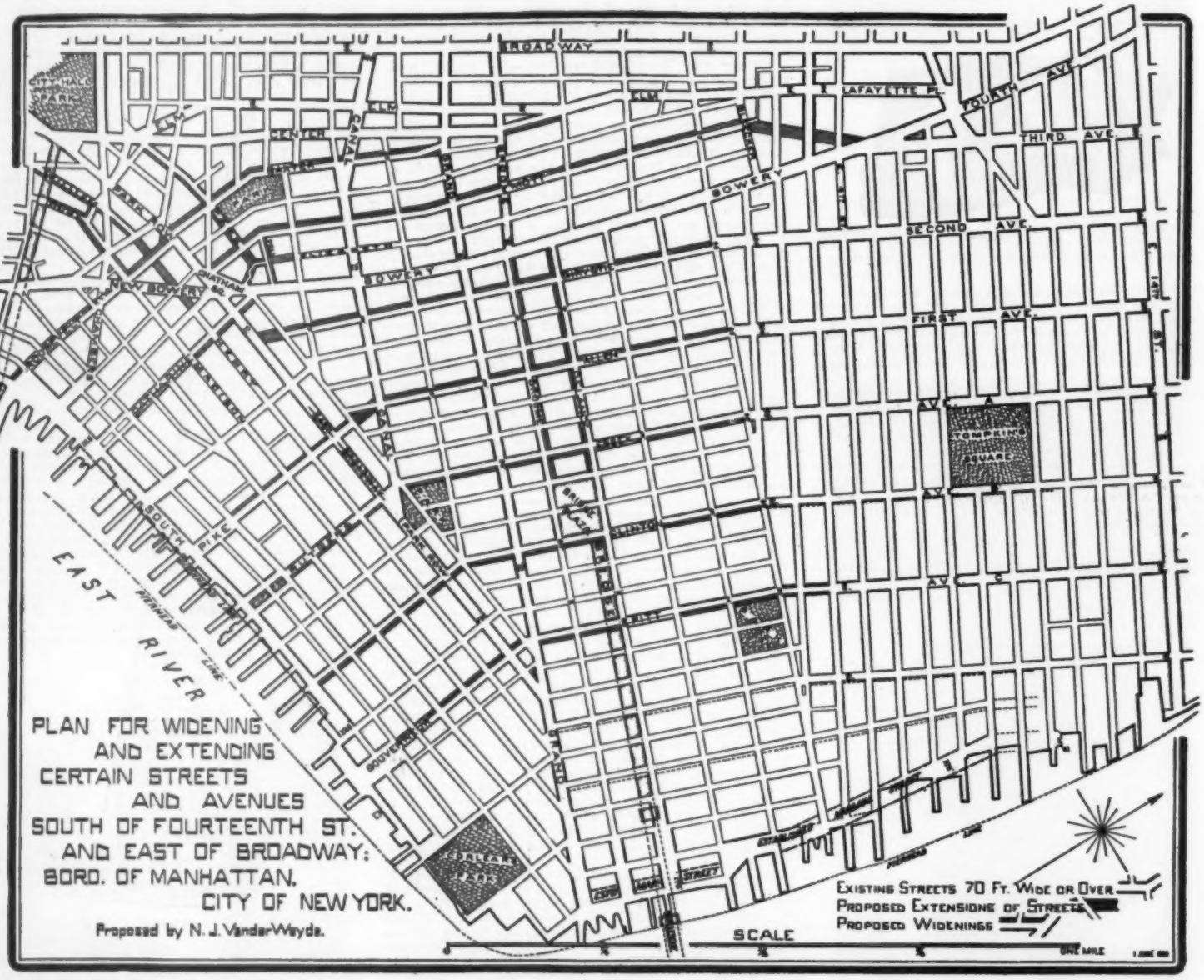
The masses of caterpillars beneath the bands are sometimes killed by pouring on kerosene. If this method is employed, great care should be taken not to add enough to saturate the bark. Many trees have been killed by carelessness in such use of kerosene.

Banding to Prevent Invasion.—In case of an uninfested apple orchard in the vicinity of an infested woodland, it will be advisable to band the apple trees with Raupenleim before the caterpillars are half grown to prevent invasion from them.

The same advice would hold in case of other uninfested trees in the vicinity of those infested.

Collecting Cocoons.—A large proportion of the cocoons are commonly spun where they can be reached. The destruction of these will lessen the number of moths that lay eggs for the next season's brood of caterpillars, although it will also lead to the destruction of large numbers of parasites. If the cocoons were placed in a good sized box with coarse-meshed mosquito netting over it, the escape of the moths might be prevented while the parasites might get away to continue their good work. By a little trouble the moths remaining in the box could be killed.

Attracting Moths to Light.—Like many other night-flying insects the moths of the forest tent caterpillar are attracted to lights at night. This has led to the suggestion that they may be destroyed by placing a lighted lantern over a tub or other wide vessel containing water with a film of kerosene on top. The moths fluttering about the light will fall into the kerosene and be killed. Such destruction will lessen the number of eggs for next year's brood of caterpillars.



PLAN FOR WIDENING AND EXTENDING CERTAIN STREETS AND AVENUES SOUTH OF FOURTEENTH ST. AND EAST OF BROADWAY; BORO. OF MANHATTAN. CITY OF NEW YORK.

Proposed by N. J. VanderWeyde.

PLAN FOR THE WIDENING OF NEW YORK EAST SIDE STREETS.

By N. J. VANDER WEYDE, Civil Engineer.

THE accompanying map contains a plan for widening and extending certain streets and avenues south of Fourteenth Street and east of Broadway, and represents a life-long study on the part of its designer of the need of more and better avenues of transportation in New York. Intimately familiar with the streets of the metropolis from boyhood, he has appreciated the advantages of the few street openings that have been made in his time in the lower part of the city; notably New Bowery, Church Street and Trinity Place, New Chambers, South Fifth Avenue (now West Broadway), College Place (ditto), and very recently the widening of West Street north of West Eleventh, and Elm Street, which is nearing completion, but yet remains to be appreciated.

It will be readily confessed that both travel and traffic between different sections of lower Manhattan need better facilities in regard to space to move about in, and that certain highways and byways, now almost dead to trade, need straightening and widening in the general interests of business prosperity. Above Fourteenth Street the street and avenue system seems symmetrical enough for all practical purposes, but below that line it becomes more and more chaotic as we proceed toward the lower portion of the city, where narrow and crooked streets are not only a bane to trade but too often the hotbeds of crime.

When the new East River Bridge is finally completed, its westerly end will terminate at Clinton Street, just south of Delancey, as indicated in the map, in the center of the district east of Broadway between Fourteenth Street and the Brooklyn Bridge. An imposing front and approach is promised, and a plaza covering a space of two blocks west of Clinton Street has been decided upon. A vast amount of traffic and travel will be certain to gravitate here. Consequently, it is here that the street widening scheme finds its first opening and its most important field of operations.

To begin with, Broome and Delancey Streets are to be widened under this proposed plan to eighty feet or more from the Bowery to both sides of the bridge plaza; this will give full facilities to elevated and surface railways, as well as to ordinary street traffic. The London and Paris system of having one street for up travel and the other for down is most advisable for adoption here. Certain north and south streets, east of the Bowery, should be widened to give better facilities to the traffic of the avenues north of Houston Street. These are Chrystie, Allen, Essex, Clinton, and Pitt, the good work to be continued below Division by widening Catherine, Pike, Rutgers, Clinton, and Gouverneur Streets to the river.

East Broadway (which is a direct continuation of and should be renamed Park Row), Canal Street and Grand Street seem to be wide enough, but Park Row east of Chambers (once the famous Chatham Street) is too miserably narrow for the traffic it carries. It is like the neck of an hour glass, there being no other ready way of getting from the Bowery to City Hall, the Bridge, or the Post Office. Property values are high on old Chatham Street and there certainly is considerable prejudice against any radical measures in this quarter, but upper William and Rose Streets might be extended and widened to meet Henry and Madison and give some relief to Park Row on the south side.

The Elm Street widening has been carefully plotted on this map; it only remains for Marion Street, north of Broome, to be widened one block to give Center Street adequate connection therewith. Baxter and Roosevelt Streets should be widened as well as Mott Street; the upper end of the latter to be extended through four blocks to the head of the Bowery, offering direct facilities to traffic on Third and Fourth Avenues and relieving excess of travel on the Bowery as far as Chatham Square.

Elizabeth Street is but a narrow affair and offers no special inducements for widening, but in order to clean out Chinatown, it is proposed to extend this street one block southerly into Pell Street, to widen the latter to eighty feet, to widen and straighten Doyer Street so as to leave but one angle in it, and then to cut Park Street through from Mott Street, forming a Y in the triangular block north of Chatham Square. Park Street might then be advantageously widened as an additional relief to Park Row.

A continuous marginal street along the East River is still a dream of the future, many engineering difficulties presenting themselves which are not encountered on the North River water front (see No. 1218 SCIENTIFIC AMERICAN SUPPLEMENT); but it will no doubt be realized in the near future, as commerce is seriously handicapped for the want of it. In regard to West Street, the writer proposes an elevated freight railway having direct connections with the Hudson River Railroad and the Western railways coming over the projected Hudson River Bridge and having spurs on the various steamship piers, where overhead loading and unloading could be carried on direct with the holds of the vessels without interfering with the use of the main decks of the piers. This would offer facilities to the shipping trade unequaled in any other seaport in the world.

It is not expected that this whole scheme, or any great part of it, can be undertaken at any one time, but if a general plan of improvements is once adopted it can be carried out in sections, the most necessary work being taken up first. This will obviate a method of haphazard alterations bearing no relation to each other or the general layout of city streets, as is so apt to be the case where no comprehensive plan to benefit the city as a whole is kept in view.

COMPARATIVE COSTS OF CABLE, ELECTRIC, AND HORSE TRACTION IN NEW YORK.

THIS article, for the first time in the history of street railroading, gives a true comparison of the relative cost of operation of cable, electric, and horse railways in a single city and under substantially the same conditions by a company controlling the local transportation of over 250,000,000 passengers per annum. On broad principles the company's experience points unmistakably to the great superiority of electricity over both horses and cable, not only in traffic handling capacity, but in economy.

On January 1, 1893, the entire street railway system of New York city was operated by horses. The importance of doing away with horse traction, in the in-

terests of both the city and the company, became so great, however, that it was at last determined to try the underground conduit electric system, which had previously been a failure in America wherever installed, owing partly to climatic conditions and partly to an attempt to use too shallow and cheap a conduit. From the first experiments onward the conduit system proved a thorough success.

The annual and quarterly reports included in this article show that during the twelve months' period the company operated 34·2 per cent. of its car mileage by the cable system, 20·2 per cent. by the electric system, and 45·6 per cent. by horses. During the last quarter, however, the proportions were greatly changed, the cable mileage being only 27·2 per cent. of the total, the horse 33·7 per cent., while the electric had risen to 39·1 per cent.

The relative traffic densities, measured by the receipts per mile of track and per car mile as shown in the quarter's report, are as follows: Cable, $39,000 per mile of track and $0·333 per car mile; electric, $17,000 per mile of track and $0·260 per car mile; and horse, $8,000 per mile of track and $0·288 per car mile. The average earning power of the entire system was about $14,000 per mile of track and $0·29 per car mile. These figures per track mile are for the quarter only. Another gage of traffic density is found in the statement that the 11 per cent. of the company's entire mileage which is operated by the cable system is earning 28 per cent. of the total passenger receipts; the 28 per cent. which is operated by the electric system is earning 32 per cent. of the total passenger receipts; and the 61 per cent. which is operated by horses is earning but 30 per cent. of the total passenger receipts.

For the year, the operating expenses of the cable lines were 16·42 cents per car mile, of the horse lines 17·87 cents, and of the electric lines 10·23 cents. For a three months' period offering more favorable circumstances for electric traction the cable lines cost 17·55 cents, the horse 17·89 cents, and the electric 10·06 cents. The electric lines during the twelve months' period earned 16·76 cents net per car mile, or but 1·25 cents less than the cable system, in spite of the fact that the latter has 7·43 cents per car mile greater receipts, while for the three months' period the net earnings of the electric lines per car mile were actually greater than the cable lines by 0·25 cent, and greater than those of the horse lines by 5·04 cents.

It overturns all established ideas to find that two temporary electric power stations can actually produce power for heavy electric cars 22 to 28 feet in length at a cost less by 30 per cent. (in the quarterly statement) than can be done in two cable power stations which operate cables so heavily loaded as to make the proportion of live to dead weight greater probably than that of any cable railway system in America, except with the possible exception of the State Street line of the Chicago City Railway Company. In the transportation expenses we find again that electric traction is the cheapest of the three motive powers, and the reason for this is found chiefly in the greater speeds of car possible with electric traction, which increases the service divisor. In the quarterly statement it is seen that in every grand division of operating expenses electricity has a decided advantage over the cable system, and in every division except maintenance of equipment it has an advantage over the horse system.

During the twelve months' period the cable lines operated at 47·7 per cent. of their passenger receipts, the electric lines at 37·9 per cent., the horse lines at 65·3 per cent., and the entire system at 53·3 per cent. During the three months' period the cable lines operated at 52·7 per cent. of their passenger receipts, the electric lines at 38·6 per cent., the horse lines at 62·1 per cent., and the entire system at 50·9 per cent. It should not be hastily assumed from the above statements that the conduit system could be adopted with financial or engineering success by street railway companies in general. New York city and Washington, which have the only electric conduit roads of any size found in America, are peculiarly favored in the matter of climate and cleanliness of streets, the rainfall and snowfall during the year being extremely small.—Street Railway Journal.

AUTOMATIC STOP BRAKE FOR VEHICLES.

WE illustrate herewith a new stop brake which possesses every advantage of a rope brake, with the additional one of being automatic.

The bar, *A*, which is always actuated by a pedal, is connected through a rope with the lever, *B*. This latter is fixed upon a horizontal shaft, *C*, which is provided with eyes, *D*, to which the traces are hooked, and a lever, *F*, which is pulled backward by a very strong spring. The shaft, *C*, is capable of revolving freely in two supports that are fixed beneath the fetchels. Its rotation is limited by two stops that arrest the motion in front of the pieces, *D*.

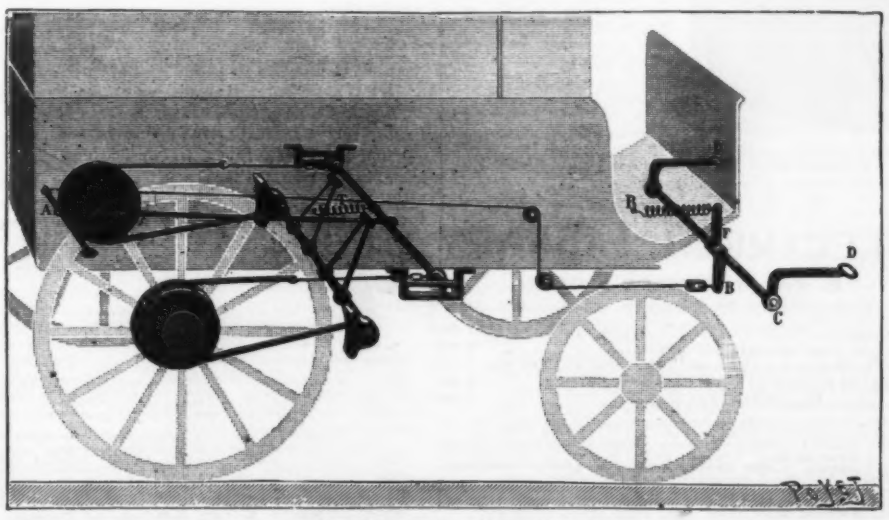
The operation is very simple. As soon as the horses pull, the levers, *D*, advance to the front as far as to the stops, along with the lever, *F*, fastened to the shaft, *C*. The spring, *R*, yielding to the traction of the traces, is stretched by the forward motion of the lever, *F*.

The lever, *B*, inclines to the rear, the rope slackens, and the rope brake is freed by the spring, *T*.

If, through a slowing up, a stoppage, or any other cause, the traces slacken, or, in other words, if the vehicle tends to move faster than the horses, as often happens in going down hill, the spring, *R*, will pull back the lever, *F*, the shaft, *C*, will revolve, and the lever, *B*, moving forward, will tauten the cable that pulls the bar, *A*, through the intermedium of a rod, and the brake will operate progressively and automatically without the intervention of the coachman in any manner whatever.

The operation and the advantages of this apparatus are, as has been stated, the same as those of rope brakes, to which this new arrangement may be applied so as to render them absolutely automatic. Naturally, the coachman always retains control of the brake by means of the pedal.

For the above particulars and the engraving we are indebted to La Nature.



AUTOMATIC STOP BRAKE.

A NEW PRIMARY BATTERY CELL OF LARGE CAPACITY AND HIGH ECONOMY.

ALL the copper sulphate cells that have been devised are constructed on one of two quite distinct principles. In one type the two fluids, copper sulphate and zinc sulphate, are separated by a porous partition of porcelain, canvas, paper, parchment, etc., as in the Daniell, Carré, and O'Keenan cells; while in the other type they are separated by the difference in density at various degrees of concentration, as in the Thompson, Calland, and Meidinger cells. Cells constructed on each of these principles have their defects, however. In those of the first kind, the cups, besides varying in porosity, offer a more or less appreciable resistance; while the fluids percolating through the porous partition mingle and accelerate the decomposition of the copper sulphate, thus increasing the consumption and incurring a loss. In this type of cell there is also a notable diminution of the electromotive force.

The defect of the second type is that as the liquids are superposed according to their density, there comes a time when even the slight agitation caused by the action in the cell causes the two liquids to mix, so that the solution has to be thrown away before it is exhausted.

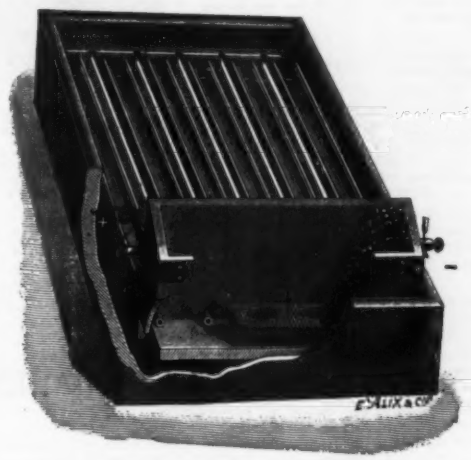
In order to be perfect, a copper sulphate battery must fulfill the following conditions: (1) It must not have any porous partition. (2) It must not be based on the superposition of liquids of different densities. (3) It must furnish a constant current until the electro-positive electrode is completely used up. (4) It must consume the products used in the reaction in theoretical quantities only, without loss or waste. (5) It must be so constructed that the metallic copper coming from the reduction of the sulphate of copper may be wholly recovered, in an immediately convertible form. (6) It must not allow any crystallization to take place in the form of creeping salts.

All copper sulphate cells heretofore known consume at least double the amount of chemical products theoretically required, principally because of the incomplete utilization of the active materials resulting from the disposition made of them.

Per ampere-hour, the theoretical figures of consumption of chemically pure products in sulphate of copper piles are as follows:

Copper sulphate decomposed.....	72·06 grains.
Zinc dissolved	18·98 "
Copper recovered from the sulphate.	18·36 "

The Jeanty cell, which we are about to describe, and which is shown in the annexed illustrations, seems to fill all the theoretical and practical conditions. It



THE JEANTY BATTERY—DETAILS OF THE ZINC SULPHATE COMPARTMENT.

THE JEANTY BATTERY—ARRANGEMENT OF POSITIVE TROUGHS AND NEGATIVE PLATES.

consists of (1) a wooden tank suitably coated so as to make it tight, and of (2) a wooden inner tank which fits in the outer one and has a partition across one end, forming a compartment in which to place the sulphate of copper crystals. This compartment is connected by a series of glass tubes near its bottom with a number of copper-lined troughs or channels also tight and impermeable. Strips of zinc are placed edgewise in the spaces between the troughs; and these strips form the negative element. They are connected with a strip of copper, the end of which forms the negative terminal of the cell. The copper strips which form the positive electrode are connected in the same way by an insulated copper strip crossing under the channels.

To charge the cell, after placing the inner tank containing the electrodes in position, a solution of zinc sulphate at 16° Baumé is poured in till the channels and zinc strips are completely immersed. After placing a wire gauze strainer in the bottom of the compartment for the purpose of keeping the glass tubes from becoming choked with the impurities of the sulphate crystals, ordinary copper sulphate is introduced.

The zinc sulphate enters the compartment through the glass connecting tubes and dissolves the sulphate of copper crystals. The sulphate of copper solution thus formed, being heavier than the zinc sulphate, passes through the glass tubes into the channels, and forms a layer over the copper strips with which they are lined on the bottom. This layer gradually increases in height, rising to within about a quarter of an inch of the top, but never running over the edges.

The cell is then put in use, and the strips of zinc are gradually eaten away, while the zinc sulphate formed by this action tends to concentrate the solution, and cause the denser portions of it to settle in the bottom of the tank below the troughs by reason of its density. The solution of sulphate of copper in the troughs is also reduced at the same time, whereupon more sulphate crystals are dissolved and fresh copper sulphate solution flows into the troughs to replace that which has disappeared. This automatic feed works with such regularity that the blue cloud in each of the channels does not vary in the least, whatever may be the intensity of discharge of the cell. When the cells are put in open circuit, the solution, after awhile, becomes saturated with sulphate of copper and cannot dissolve more. When this occurs, the cell does not really consume anything, as is demonstrated by an examination of the crystals, the amount of which remains the same while the circuit is left open.

Finally, the cell does not consume the active materials except in exact proportion to the amount of current which it furnishes; and as the materials are so placed that their consumption is absolutely impossible when no current is being produced, it follows that a given quantity of the active materials can be wholly utilized.

The constancy of the flow of current is due to the fact that the two electrodes (zinc and copper) are always immersed in liquids the density of which scarcely varies, thus keeping their conductivity always the same. In fact, the zinc sulphate, as fast as it is formed, becomes so concentrated as to settle to the bottom of the tank, where it spreads out in the main mass of liquid; while the zinc strips are kept constantly in the upper part of the solution, which is less concentrated and most conductive. For the same reason creeping salts cannot be produced, since the upper layer of the liquid is constantly dissolving the salts that are formed.

From experiments made in June, 1898, in the electri-

cal laboratory of the Ecole de Physique et de Chimie Industrielles, at Paris, as well as from practical use, it appears that the Jeanty cell consumes the following amounts of zinc and copper per ampere-hour:

Commercial copper sulphate.....	74·07 grains.
Impure commercial zinc.....	21·14 "
Amount metallic copper deposited.....	16·28 "

The amounts consumed in a useful kilowatt-hour are as follows:

Commercial copper sulphate.....	14·44 pounds.
Impure commercial zinc.....	4·11 "
Amount electrolytic copper deposited.....	3·00 "

In the experiments that were made, a cell was charged the 30th of April and kept in continuous closed circuit till the 3d of June, a period of thirty-four days. At the end of this time the cell still contained 2·63 pounds of the 6·96 pounds put in it when it was charged, and this could be used again when it was recharged.

The Jeanty cell will use the products in a raw state, and the zinc used may be of the roughest commercial kind, thus making the cost of current as low as 25 cents per kilowatt-hour.

The cell has been used successfully for charging accumulators for lighting; and when so used the net cost of the light was found to be one cent per lamp hour of 10 candle power. This figure is not extraordinary when the crudeness of the chemicals used and the fact that they are entirely consumed is taken into account.

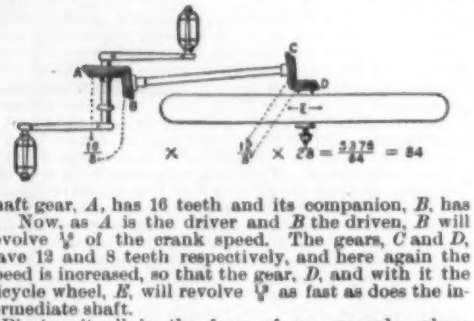
Important incandescent and arc light installations have been made with this cell as generator of electricity; and experiments are now being made by the Railway of the West for operating a new system of signals with it. For this purpose it is necessary to have a large amount of constant current, at as low a price as possible. Finally, several owners of electric automobiles use it with success for charging the accumulators of their carriages at their residences, during the night hours. A noteworthy application of the cell is also found in the lighting of the steamer "Touriste," which plies between Paris and Saint-Germain-en-Laye.—Cosmos.

HOW TO FIGURE A CHAINLESS GEAR.

IF one gear is driven by anotber, and the two gears have each the same number of teeth, they will make the same number of revolutions in a given time.

If one runs faster or slower than the other, it is because it has more, or less, teeth, and it will run as much slower or faster as its teeth are fewer or more numerous.

We have taken the liberty of mixing mathematics and mechanism in the sketch herewith. The crank-



shaft gear, *A*, has 16 teeth and its companion, *B*, has 8. Now, as *A* is the driver and *B* the driven, *B* will revolve ½ of the crank speed. The gears, *C* and *D*, have 12 and 8 teeth respectively, and here again the speed is increased, so that the gear, *D*, and with it the bicycle wheel, *E*, will revolve ½ as fast as does the intermediate shaft.

Placing it all in the form of an example, where "cancelation" may be employed if desirable, we have ½ of ½ of 28 inches, which equals $\frac{18}{8}$ or 84 inches.

The above is an attempt to give the "reason why" rather than simply a formula.

The same would apply to a chain wheel, except that there are less factors. If the front sprocket had 18 teeth and the rear one 8, with a 28-inch wheel, the "arithmetic" of it would be:

$$\frac{18}{8} \times 28 = 63.$$

—L. A. W. Bulletin.

RADIATION OF LUMINOUS PAINT.

BALMAIN'S luminous paint has certain curious actinic properties which differentiate it from other luminous bodies and from the bodies emitting Le Bon's "dark light." In a preliminary report, L. Kann describes how he exposed a screen of that paint to sunlight, and then laid it on a sensitive plate, inserting various substances, such as paper, cardboard, wood, and aluminum, between the plate and the luminous screen. The most curious observation is that pointed letters on a card were photographed even through a sheet of aluminum, and that impressions were obtained apparently without the special treatment by which Le Bon sensitizes his plates for obscure radiation. That some form of dark radiation is at work is shown by the fact that essentially the same results are obtained long after the screen has ceased to be luminous. The vapors of the interposed substances are certainly not responsible for the impression on the sensitive plate, since on removing the luminous screen and leaving the substances in contact with the plate for five days, no impression is obtained. The active rays, whatever they are, penetrate white paper more rapidly than black paper. It was, indeed, found possible to print on the photographic plate very plainly within half a minute the name on a visiting card inclosed in a very heavy envelope.—Phys. Review.

Excavations in Rome still continue and the black stone which was believed to mark the burial place of Romulus was found. The stone has been dug under, and amid many votive offerings a cippus of tufa rock marked with an alphabetic inscription has been found. The characters are Archæan. This may possibly seem to indicate a Greek origin to Rome like that of Marseilles and may go back of the traditional "year of the city," 753 before Christ.

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TABLE OF CONTENTS.

PAGE

I. ARCHITECTURE.—Mechanical Influence in Architecture.—6 illustrations. 19634

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III. BICYCLES.—How to Figure a Chainless Gear.—1 illustration. 19644

IV. CIVIL ENGINEERING.—Plan for the Widening of East Side New York Streets.—By N. J. VANDER WEYDE.—1 illustration. 19642

V. COMMERCE.—Trade Suggestions from United States Consuls. 19637

VI. ECONOMIC ENTOMOLOGY.—The Forest Tent Caterpillar.—By CLARENCE M. WEED.—6 illustrations. 19640

VII. ELECTRICITY.—A New Primary Battery Cell of Large Capacity and High Economy.—2 illustrations. 19643

VIII. HYGIENE.—Boston's Free Municipal Bathing Plant.—By J. A. STEWART.—4 illustrations. 19632

IX. MATHEMATICS.—Origin of Arabic Numbers.—2 illustrations. 19633

X. MECHANICAL ENGINEERING.—Automatic Stop Brake for Vehicles.—1 illustration. 19643
Comparative Costs of Cable, Electric, and Horse Traction in New York. 19642

XI. MISCELLANEOUS:
Engineering Notes. 19636
Electrical Notes. 19636
Miscellaneous Notes. 19636

XII. NATURAL HISTORY.—Puma-Leopard in the Zoological Garden at Berlin.—1 illustration. 19639

XIII. PATENTS.—Women Inventors.—By GEORGE ETHELBERT WALSH. 19633

XIV. PHOTOGRAPHY.—Flexible Films for Spectroscopic Photography. 19639

XV. PHYSICAL GEOGRAPHY.—A Seismological Observatory and its Objects.—By JOHN MILNE. 19638
The Abyss of Padirac.—3 illustrations. 19638

XVI. PSYCHOLOGY.—Curious Effects of Mental Suggestion. 19639
The Physiological Basis of Mental Life. 19632

XVII. TECHNOLOGY.—The Purification of Acetylene.—By P. WOLFF. 19635

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The * Indicates that the Article is Illustrated with Engravings.

A

Abrading material, new 19269
Abyss of Padirac *19038
Abyssinians, notes on *19922
Accumulators, motor car 19333
Acetylene 19280, *19330, 19384
Acetylene burners 19316
Acetylene, explosive mixture 19316
Acetylene for gas motors 19272
Acetylene for railway cars 19257
Acetylene gas 19308
Acetylene lamp, new *19387
Acetylene, purification of 19335
Acoma, New Mexico *19488
Acropolis of Athens *19552
Age, old, retarding 19277
Agents, traveling 19420
Agriculture, British, 1898 19506
Air, liquid, and explosives 19597
Air, liquid, phenomena of *19504
Air, regeneration of 19556
Air rich in oxygen, applica 19573
Air under electric stress 19274
Air vessels, dirigible 19457
Aldehyde, formic, disinfection *19412
Alethorama *19258
Alkali soils, Yellowstone Val *19542
Alloy, iron and nickel 19381
Alloy, nickel and steel 19304
Alloys for brushes 19605
Almanacs and Weather Bureau *19279
Almondkleie 19605
Aluminum, action of acids on 19509
Aluminum in brass 19540
Aluminum, silvering 19413
Aluminum, to drill 19576
Ambulance, automobile 19540
Ammonia, cloudy 19365
Animal fear of man 19489
Animals, criminal 19364
Anthropometry, school of *19816
Ant-inhabited plants *19038
Ants, battle between 19364
Ants, tropical, intelligence 19548
Arc, reduc. of metals by 19461
Architecture, mechan. influence *19634
Arctic, residence in the *19606
Argon, pure, preparation *19466
Arithmetic among Egyptians *19498
Armor plates, manufacture 19269
Army camps, hygienic 19621
Arrow poison, urari 19620
Art, plastic, in Europe *19295
Art, prehistoric *19552, *19577
Artists, Austrian, Union of *19287
Asphalt streets, Germany 19588
Assistance, the tug 19445
Assyrians, ethics of the 19936
Athens, Acropolis of *19552
Atmah, steam yacht *19343
Australasia, trade conditions 19604
Auto-lux, the *19403
Automobile exhibition, Paris *19334
Automobiles in Paris *19602
Auto-sighting for artillery 19573

B

Babylonians, ethics of 19936
Bacteria and their uses 19408, 19478
Bacteria on old bronze 19316
Bacteria, photographing 19597
Baldness, lotion for 19005
Baldness, treatment of 19349
Ball bearings 19383
Balls for bicycles 19278
Balloons, dirigible 19457
Barber shop vs. health 19305
Barometers, aneroid 19276
Barometers, paper 19633
Bastille, prisoners of 19322
Bathing plant, Boston *19631
Baths, fixing 19285
Battery, a new *19627
Battery cell, Jeanty *19643
Battleship, German, new *19567
Bearing, thrust 19349
Bearings, roller, friction in 19492
Bed of Napoleon *19562
Beds of various nations 19577
Bedbug destroyer 19681
Bedbug poisons 19005
Bee, honey *19354
Beer in Spain 19444
Bergamot, Calabrian 19467
Bicycle exhibition, Paris *19324
Bicycle factory, a large 19433
Bicycle, gasoline *19304
Bicycle lamp oil 19656
Bicycle lubricating oil 19556
Bicycle, military, folding *19559
Bicycle paint 19556
Bicycle tire cement 19556
Bicycle tires 19433
Bicycle trade in Canada 19637
Bicycles, American, abroad 19400
Bicycles, American, in England 19420
Bignonia purpurea 19274
Bilge keels 19365
Bird song, evolution of 19391
Birds, age attained by 19509
Birds, love gifts of 19579
Birds, wild, bad language 19389
Biserta suspension bridge *19490
Bismarck, sarcophagus of *19474
Blackberry cordial 19589
Blackboards, slating for 19285
Blackhead lotion 19445
Black death in Bucharia *19511
"Blacklight," Le Bon's *19629
Blast, monster 19337
Blasting in collieries 19349
Blasting under water *19250
Blasting with steam 19636
Blowing engines, compound *19636
Blue Hill Observatory *19376
Blue printing processes 19612
Blue, Prussian 19515
Bluing, laundry 19445, 19514
Boat, an unsinkable *19490
Boats, electric, new 19304
Boats, submarine *19586, *19310
Boats, torpedo, speed record 19303
Body, human, electric resist 19413
Boiler flue drilling machine *19459
Boiler furnaces, new *19330
Boiler scaling hammer *19594
Boiler, water-tube *19314
Boiler work in United States navy 19285
Bolts, American, in Scotland 19493
Bone, red mordant for 19081
Bones, softening of 19336
Bonn bridge, new *19402
Boring and threading machine *19330
Boring machine, improved *19523
Boring tools, broken, extract 19365
Bottles, emptying, device for *19412
Brake for steamships 19316
Brake, stop, automatic *19643
Brandy, essence of 19492
Brass, aluminum in 19540
Breastworks, storming *19607
Breech mechanism, Vicker *19499
Brick and clay in the Bible 19319
Brick statistics 19514
Bridge at Dusseldorf *19328
Bridge, Bonn, new *19402
Bridge, oldest in Europe 19024
Bridge, suspension, Biserta *19490
Bridges over the Tiber *19346
Briquettes, domestic 19408
Briquettes, turf 19594
Bronze casting, improvements 19272
Broom handles in Great Britain 19524
Brougham electric *19002
Brushes, alloys for 19605
Buchara, "Black Death" in *19510
Bulb growing *19291
Burner, Bunsen, new type 19492
Buttons, unio shell *19290

C

Cables, submarine, Philippine 19481
Cabs, electric, Paris 19589
Cachous, aromatic 19338
Cagliostro, Paris house of 19585
Caiman, French ship *19811
Calcium carbide 19433
Camels in America 19310
Camera, cigematograph *19467
Camps, hygienic 19621
Canada, bicycle trade in 19637
Canada, electric railways 19636
Canal, Dismal Swamp 19413
Canal, Nicaragua *19440
Canal, ship, statistics 19267
Canned goods in Germany 19444
Caravans, Tartar *19286
Carbon in organic liquids *19497
Carbon vapor in the sun 19580
Car couplers, auto., in Europe 19572
Car lines, electric, Germany 19540
Carriage greases 19309, 19304
Carriages, automobile, Paris *19602
Caterpillar, tent forest *19640
Cathedral, Tarragona 19081
Caucasus, mission to *19430
Cement, bicycle tire 19556
Cement coating for iron 19098
Cement for rubber goods 19656
Cement for tires 19557
Cement, Portland 19049
Cement, tire 19285
Cements, disintegration of 19573
Chainless gear, how to figure *19644
Chapel, a colliery 19492
Chartreuse liqueur, origin of 19005
Chemistry, museum of 19298
Chimney construction, new muth 19556
Chimney fires 19381
China, Empress of *19279
China, into the heart of 19616
China glazes 19472
China, labor saving devices 19420
Chitose, cruiser, Japanese *19407
Christmas Island 19361
Chromoscope, Ives *19273
Chrysanthemum, new *19259
Church, highest in Europe 19555
Cigar flavors 19540
Cigar speckling liquid 19624
Cinematograph camera *19467
Circuit breaker, Woehnelt's *19475
Civilization, Egyptian 19475
Clock, a heat-wound 19433
Cloth pressing, electric 19571
Clouds, photographs of 19454
Coal, American, in Buenos Ayres 19445
Coal fields of the world 19636
Coal for a large hotel 19474
Coal imports into Spain 19509
Coal supplies, British 19568
Coal tar heating *19387
Coal, the future of 19369
Coal, wooden boxes for 19297, 19430
Coaling stations, new 19636
Coca malt phosphate 19624
Coffee production, world's 19476
Coke, domestic 19408
Collieries, electric blasting 19349
Colonies, American, laws of 19528, 19537
Columbus, remains of *19414
Comet photography *19546
Commerce, depart., G. Britain 19641
Commerce in France, study of 19557
Condensation in steam engines *19554
Condenser, ejecto, Bohler *19554
Conductors, non, deposits on 19002
Copper casting 19381
Copper, casting, new method 19556
Copper roofing 19004
Copper sulphate in France 19460, 19004
Copper sulphate process 19289
Copra, crushing of 19397
Cordial, blackberry 19589
Cordierite, history 19415
Cores, metallic, for mortar 19577
Cork tree, the 19593
Cornwall, mining in 19322
Corporations, New Jersey 19446
Cosmetic, hand 19098
Cosmoscope, the *19612
Cotton, American, baling 19444
Cough cure 19257
Coupler, automatic 19589
Cradle incubator *19513
Crane, Titan, a large 19573
Crane, 33-ton *19603
Cream separator, Fram *19518
Crime and the weather *19502
Criminal animals 19364
Cripples, manufactured in Spain 19505
Crossing and interbreeding 19476
Crucibles, cracking of 19624
Cruiser, Chitose, Japanese *19407
Crusaders, life among the 19510
Cuba, mineral resources of *19296
Cuba, postal service in 19459
Cuba, railways in 19539
Curare, uses of 19620
Cycle exhibition, Paris *19334

D

Dam, Feriar *19455
Da Vinci, inventions of 19307
Dead, disposal of the 19255
Dentifrice powder 19509
Depilatory cream 19556
Designs, ornamental, in clay 19269
Developer, metal and pyro 19285
Diadem, H.M.S., engines of *19306
Diatomite 19347
Dice table, magnetic 19325
Dietaries of slums 19481
Directory, the London 19445
Diseases of nations 19293
Disinfectants, liquid 19476
Disinfection apparatus, new *19412
Distances, measuring 19433
Djibouti to Harrar *19378
Dock, dry, a natural 19381
Dock, dry, the largest known 19589
Dock for Barcelona 19455
Dog soap 19461
Draba Olympica *19348
Drawing by fire *19450
Drawings on photographs 19365
Dredge for Russian canals 19491
Drilling machine, boiler flue *19459
Drinks, malted 19624
Drydock, new 19323
Drydock, Stettin *19249
Dusseldorf bridge *19328
Dyer, education of the 19290
Dyes for wood 19349
Dynamo and engine *19331
Dynamos, how sold 19671
Dynamos, use of gas motors 19345

E

Earth, plan of the 19369
Earths, infusorial 19347
Earthworms *19601
Education, commercial, Antwerp 19517
Eggs as weight producers 19433
Eggs used in the industries 19467
Egypt, civilization of, origin 19475
Egypt of Iowa 19582
Eiffel Tower, novel use for 19033
Ejecto-condenser, Bohler *19554
Electrical notes 19285, 19304, 19349, 19365, 19413, 19445, 19461, 19478, 19625, 19540, 19573, 19589, 19605, 19636
Electricity, applications of 19636
Elephant and his ancestors *19618
Elephant in India *19259
Elevator, grain, pneumatic *19095
Elevator, the first 19073
Elevators, electric 19589
Emerald mining in Russia 19550
Emotions, therapeutics of *19371
Empress of China *19279
Enameling as an industry 19613
Enamels, vitreous 19456
Engine and blower *19027
Engine, compound, vertical *19331
Engine, gas, Longsdon *19267
Engine, gasoline, portable *19523
Engine, petroleum *19315
Engine, steam, first American 19624
Engine, steam, largest 19589
Engine, steam, Watt's 19556
Engines of H.M.S. Diadem *19306
Engines of the Ultonia *19506
Engineering, ancient *19366
Engineering business, U. S 19589
Engineering notes 19257, 19269, 19285, 19304, 19316, 19333, 19340, 19365, 19381, 19413, 19433, 19402, 19509, 19540, 19566, 19573, 19589, 19624, 19636
Ermak, ice-breaking steamer *19519
Essences, wine, artificial 19492
Etching on steel 19509
Evolution, theory of 19416
Excavator, electric *19267
Explosion in restaurant *19255
Explosion, powder magazine *19462
Explosive, new, kallenite 19556
Explosive, new, lyddite 19371
Exporters to China, advice to 19419
Exposition of 1900 ..... *19002

F

Fan motors, speed of 19605
Fans, centrifugal, capacity 19422
Feed apparatus wanted 19365
Fences, locomotive tube 19636
Fertilizers in Japan 19444
Fever, malarial, etiology 19461
Fig culture in Greece 19588
Figures, Arabic, origin of *19633
Films, flexible 19639
Filter, aseptic 19294
Filter, water, new *19326
Fingertip prints 19281
Fireproofing tissues 19365
Fire engines, electric, Paris 19636
Fire engine, steam *19554
Fire extinguishers 19433
Fire prevention society 19418
Fire testing station 19500
Fisheries, Lofoden 19493
Floor polish 19316
Flour, American, in Brussels 19420
Flowers, blue, unproducible 19568
Flying machine *19335
Food of the poor 19431
Food supply of the world 19353
Forest preserves, New York 19433
Forest reservations, United States 19401
Formosa, American trade in 19541
Formulæ, selected 19257, 19269, 19285, 19304, 19316, 19333, 19349, 19365, 19381, 19398, 19413, 19433, 19445, 19461, 19476, 19492, 19509, 19525, 19540, 19556, 19573, 19589, 19605, 19624
Forum, Roman, excavations *19423
Freckle lotion 19476
Freezing mixtures, isolating 19461
Fruit, a new *19297
Fruit, another new *19323
Fuel, liquid 19004, 19409
Fulmen cell, notes on the 19589
Fulton, U. S. steamer 19314
Furnaces, boiler, new *19330
Furniture, American, exports 19577

G

Galvanism in insect bites 19540
Gas, acetylene 19280, 19308, *19339, 19384
Gas, acetylene, for cars 19257
Gas, acetylene, purification 19335
Gas and oil engines *19491
Gas engines for dynamos 19345
Gas engine, Longsdon *19266
Gas engines and lighthouses *19694
Gas lighter *19436
Gas lighter, new *19315, *19403
Gas motors, acetylene for 19272
Gas meters, coin in slot 19532
Gas, natural, composition 19492
Gas, natural, Indiana 19381
Gas, oil, Stanislau 19413
Gases, atomic constitution 19068
Gases, furnace, scrubbing 19624
Gases, liquefaction of 19353
Gases, permanent, constants of 19504
Gasoline bicycle *19304
Gasoline engine, portable *19523
Gasoline motor, new *19266
Gear, chainless, how to figure *19644
Gelatin solutions, setting of 19646
Generator, the Turgan *19594
Geographical discovery 19301
Geological Society of America 19288
Germany, commercial develop 19606, 19637
Germany, merchant marine 19637
Gibraltar, trade in 19557
Gin, essence of 19492
Girders, corrosion of 19596
Glass blowers, protection of 19633
Glassblowing, lamp for *19261
Glass, effect on light 19294
Glass, plate, manufacture *19270
Glass, solder for 19625
Glass sweating, to prevent 19285
Glazes, leadless 19472
Glove cleaner 19433
Glove manufact., Germany 19025
Gold fields, California 19313
Gold mines, West Africa 19424
Gold mining and minting *19252
Gold region, a new 19098
Goods, U. S., Scotch opinion 19323
Governor for heavy motors *19409
Grafting, methods of *19489
Grain elevator, pneumatic *19095
Grape juice, manufacture 19024
Graphite, manufacture of 19029
Greases, carriage 19269, 19304
Growth affected by thinking 19580
Gun, a flashless *19438
Gun, Brown wire wound 19509
Gun, fire department 19365
Gun, Gatling, 8-inch *19284
Gun, machine, Maxim 19268
Guns, wave action in *19581
Gunboat Princeton 19333

H

Hacienda, house of a 19636
Hacks, electric, in Paris *19570
Hæmoglobin preparations 19257
Hair industry in France 19412
Hair invigorator 19605
Hamburg harbor 19433
Hammer, boiler scaling *19594
Hand, the, in disease 19325
Hawaii, commerce in 1898 19557
Heart disease, note on 19458
Heat, waste, at sea 19272
Heating by coal tar *19387
Hemp working machinery 19477
Heredity, theory of 19414
Honduras, imports into 19444
Honey bee, the *19354
Horse meat in Norway 19517
House, biggest known 19369
House in the woods *19613
House of a hacienda 19636
Hydrogen in organic liquids *19497
Hydrogen, liquid *1945a

I

Ice breaking steamer Ermak *19519
Identity, finger tip 19281
Illusion, an optical *19275
Iloilo, capture of *19478
Imports, colonial 19462
Incubator, cradle *19513
Ink for hand stamps 19413
Ink, red 19580
Ink, removal from carpets 19461
Ink, printing 19433
Ink, sympathetic 19556
Inks, laundry 19381
Insect bites, galvanism in 19540
Insects, economic status 19088, 19400
Insecticide, moth 19624
Instruction, commercial 19397
Instruction, scientific 19275, 19259
Insurance companies, New York 19476
Intensifier, hydraulic 19409
Interrupter, automatic *19498
Interrupter, Wehnelt *19602
Inventors, women 19346, 19633
Iodine in the air 19624
Iodoform, preparation of 19445
Iowa, Egypt of 19582
Iron, American, in South Africa 19557
Iron, cast 19421, 19427
Iron, cast, to silver 19316
Iron, cement coating for 19098
Iron, hysteresis of 19476
Iron, minium, testing 19098
Iron, pig, product, 1898 19005
Iron production, forty years 19318
Iron works, Ypanema 19540
Isawiyah, customs of 19449

J

Jamaica breweries 19025
Jamaica, trade conditions 19493
Japan, cardboard mfr. in 19396
Japan, electric science in 19285
Japan, mercantile marine 19936
Jaureguibery, ship, French *19311
Jews in Palestine 19465
Jib crane, electric, large 19413
Journals of France, number 19623

K

Kaiser Friedrich III., ship *19567
Kallenite, new explosive 19556
Karnak, temple of *19359
Keels, bilge 19365
Kieselguhr, infusorial earth 19347
Kite experiments *19376
Klondike output, 1899 19588
Koumys, substitute for 19333

L

Label paste 19005
Lacquer for tin plate 19492
Lamp, acetylene, new *19387
Lamp, arc, inclosed type 19365
Lamp filaments, conductivity 19573
Lamp for glassblowing *19261
Lamp, miner's improved 19476
Lamp, reading, a pretty 19605
Landslip at Sasso Rosso 19408
Land tenure in Russia 19197
Lanterns, American 19525
Launch, electric, motor *19263
Laundry blues, about 19514
Laundry bluing 19445
Laundry inks 19381
Laundry polish 19589
Lava flows, massive 19406
Lead, black, a graphite 19329
Lead, white, covering power *19536
Leaks in ships, detection 19573
Leather belts, life of 19492
Leather polish 19365
Leaves, green, to bleach 19469
Lenses, cleaning 19333
Life, mental, basis of 19632
Light, electric, Nernst's *19396
Lighter for gas burners *19315
Lighter, gas *19436
Lighthouse, new 19267
Lighthouses, gas engines for *19394
Lighting apparatus, new *19266
Lightning protection *19434
Lignite, distillation of 19285
Lifeboat, a new *19490
Life of man, estimation of 19492
Limestone consumption 19413
Liquefaction of gases 19052
Locomotives, Amer., in England 19460
Locomotive, compound express *19555
Locomotives, electric *19320, *19465
Locomotive, express, English *19583
Locomotive frames, steel 19433
Locomotive, high speed, French *19283
Locomotive, high speed, new *19443
Locomotive industry, 1898 19381
Locomotive industry, outlook 19509
Locomotive industry, the 19413
Lofoden fisheries 19493
Log, ship's, improved 19476
London, population, density 19268
Lozenges, laxative 19373
Lubricant for bicycles 19556
Lubricants for glass faucets 19336
Lubricant for glass stoppers 19476
Lubricants, carriage 19269, 19394
Lyddite, new explosive 19371
Lyddite shell, the 19304

M

Macassar oil 19325
Machetes in Paraguay 19493
Machinery, U. S., in Denmark 19397
Machine tools, imitations of 19404
Machines, American in England 19403
Machines, exporting to Germany 19324
Madeira wine essence 19492
Magnet, early use of 19405
Magnets, red paint for 19461
Mails, transcontinental 19445
Malaria and mosquitoes 19257, 19533
Malaria in tropical lands 19550
Malt with coca 19624
Manila, electricity in 19356
Manila, markets of 19541
Mantles, incandescent lamp 19540
Mantles, Welsbach, brightness 19258
Mastodon, skeleton of *19619
Matanzas, Cuba, scenes *19600
Match, safety, new 19445
Matches, parlor, composition 19573
Matting, straw, Japanese 19525
Meat and muscle *19491
Meat, frozen, industry 19461
Meat, tuberculous 19356
Meats, composition of 19405
Mental suggestion, effect of 19639
Mesa, the enchanted *19488
Metals, free from carbon 19553
Metals, polish for 19461
Metals, rare, market value of 19609
Meters, gas, coin in slot 19533
Mexico, Western, trade in 19493
Milk sirup, malted 19624
Milk, tuberculous 19456
Mine defense, Santiago *19530
Mines, gold, West Africa 19425
Mineral press, White *19636
Minerals of Philippines 19480
Mining in Cornwall 19622
Minium, testing 19398
Mirage 19317
Mirrors, glass, ancient 19040
Miscellaneous notes 19256, 19260, 19316, 19333, 19381, 19433, 19445, 19461, 19476, 19492, 19509, 19525, 19556, 19605, 19624, 19636
Mole, new, at Ancona 19556
Mont Blanc Observatory *19409
Montevideo port works 19588
Monument, Russian *19415
Mosquitoes and malaria 19237, 19533
Mosquito extermination 19564, 19593
Moth killer 19624
Motor car accumulators 19331
Motor car tests 19315
Motor, electric launch *19263
Motor, gasoline, new *19396
Motor patents, Tesla 19396
Motor, sewing machine *19091
Motors, electric *19282
Motors, electric, in steel works 19573
Motors, gas, acetylene for 19272
Motors, gas, for dynamos 19345
Motors, gas, for lighthouses *19394
Motors, oil and gas *19491
Motormen, school for *19554
Moulds, foundry, blackening 19540
Mountain water courses 19326
Mucilage, recipes for 19605
Muscle and meat 19491
Museums, archæological *19286
Mutoscope, the *19344

N

Nails, American, in England 19539
Nails, American, in Europe 19397
Nails, cut vs. wire 19284
Nails, finger, polish for 19304
Nan-Matal, ruins of 19274
Navigation, inland 19316
Navigation, submarine *19580, *19610
Navy, electric work in, recent 19266
Navy, French, new ships of *19311
Navy, transports for 19307
Navy, U. S., fighting force 19533
Negative, stripping film from 19509
Negatives, development of *19301
Negatives, stripping 19257
New Guinea, German *19350
New Jersey corporations 19446
New Mexico, picturesque *19488
New York streets, widening *19522, *19642
Nicaragua Canal *19440
Nickel plating small articles *19386
Nicotine in tobacco smoke 19333
Nile, damming of the 19272
Nizhni Novgorod as market 19429
Non-conductors, deposits on 19302
Numbers, Arabic, origin *19633
Nutrition investigation 19404

O

Oak, a large 19509
Observatory, a seismological 19638
Observatory, Flammarion's *19626
Observatory, Mont Blanc *19409
Ocean bottom, temperature 19556
Ocean burial of the dead 19265
Oil and gas engines *19491
Oil for bicycle lighting 19556
Oil for railroad beds 19333
Oil, Macassar 19525
Oil of wheat 19310
Oil, peanut 19274
Oil, sewing machine 19304
Oil, growing, rate of 19357
Opaque bodies, transparency *19529
Opium smoking *19547
Orange boxes in Syria 19493
Oyster shells for rickets 19508
Ozone and phosphorescence *19277
Ozone in water purification 19257

P

Padirac, abyss of *19538
Paint, bicycle 19556
Paint, red, for magnets 19461
Painting, sanitary 19521
Palatine Hill, Rome *19574
Palm oil carriage grease 19269
Paper, blue print 19116
Paper, sensitized 19316
Para, trade in 19493
Paris, oil-1, restoration *19008
Passenger travel in United States 19257
Passengers, car, seating 19396
Passengers from Europe, 1898 19415
Passion flower, new *19432
Passy underground railway *19426
Paste, label 19005
Paste, shaving 19573
Patagonia, skulls from 19630
Patent rights, history of 19436
Patent systems compared 19418
Patents, Commissioner, report 19349
Patents in Germany 19005
Pavement problem, Paris 19256
Pavements, maintenance of 19339
Peanuts, and oil of 19274
Pearl buttons *19260
Pearls, artificial, production *19468
Pencils for glass sketching 19308
Pencils, slate, moulded 19556
Peoples, primitive, ethics of 19323
Perfume for the breath 19461
Perlar dam *19457
Petroleum motor *19315
Petroleum residue 19397
Petroleum, Russian and American 19257
Phaetons, electric *19394
Philippines, exports to 19588
Philippines, minerals 19630
Phosphorescence and ozone *19277
Photographs, line drawing on 19305
Photography, comet *19546
Photography, spectroscope, films 19639
Pile driving, water jet in 19396
Pin and needle, history of 19403
Pin, solid-headed, first 19433
Pinus Montezumæ *19563
Pipe line, glass 19419
Pipes, action of carbonic acid 19492
Pitchometer, the *19314
Planers, improved 19316
Planing machine, improved *19459
Plant foods 19569
Plant hunting by Egyptians 19488
Plant reproduction, agents in 19300
Plants, myrmecophilous *19338
Plaster of Paris, setting of 19316
Platform, movable, Paris *19458
Plating, nickel, small objects *19386
Plows in Italy 19397
Plumbago, formation 19629
Poland, electricity in 19626
Police instruction, Paris *19616
Polish, finger nail 19004
Polish, floor 19316
Polish for metals 19461
Polish, laundry 19589
Polish, leather 19365
Polish, shoe 19445
Polish, wax 19624
Polishing powder 19540
Poor, what they eat 19431
Pope, how elected *19515
Poppy, the Asiatic *19547
Porcupine, the American 19450
Port wine, essence of 19492
Porto Rico 19495
Porto Rico, road building 19336
Pottery glazes 19472
Postage stamp mucilage 19005
Powder magazine explosion *19462
Powder, smokeless, history 19530, 19563
Powder, smokeless, Maxim 19560
Powder industry, Germany 19413
Power, unit measurement 19344
Prague, trade in 19637
Prairie dog and rattlesnake 19555
Press, mineral, White *19326
Princeton, gunboat 19333
Printing ink 19433
Prints, blue 19540
Prison, Sante, new cells of *19627
Prisoners of the Bastille 19322
Profession, a curious 19310
Propeller, Ballot *19379
Propeller, electric *19390
Propeller made at sea 19374
Puma-leopard, the *19430
Pump, intensifier *19409
Pumpsin Mexico 19444
Punching machine *19379
Purple of Cassius 19433

Q

Queen Victoria in France *19472

R

Rail welding, Falk system 19492
Rails, endworn 19279
Rails, heavy, for Siberian R.R 19557
Rails, steel, American 19437
Railroad, city, Paris *19418
Railroad, underground, Paris *19331
Railroads, new, of 1898 19316
Railroads, Norway, projected 19517
Railroads, street, operating 19304
Railway, Djibouti-Harrar *19378
Railway, Acre-Damascus 19536
Railway, electric, Boston 19624
Railway, Germany to Italy 19449
Railway, London, Central *19267
Railway, Mont Blanc, new 19556
Railway, Russian, new 19257
Railway, Sierra Leone 19633
Railway signals, colored 19540
Railway station, Dresden *19366
Railway, Syria-Ottoman 19557
Railway, Tanscaspian *19398
Railway, underground, Passy *19426
Railway, Vesuvius, new 19509
Railways, elevated, Canada 19636
Railways, city, electric tract 19543
Railways, electric, Germany 19595
Railways, electric, in United States 19349
Railways, elevated, New York 19365
Railways in Cuba 19539
Railways of French Soudan *19318
Railways of Japan 19508
Railways, street, city of Mexico 19541
Railways, street, England 19372
Rameses, statue of *19359
Range finder, artillery *19483
Rat, tail of the 19614
Rattlesnakes, data on 19549
Reducer, photo 19365
Refrigerating plant, Vienna 19525
Refrigerators, marine *19428
Refrigerator, Bohler *19554
Restaurant, Paris, explosion *19255
Ribbons, typewriter 19342
Rivers and canals of Russia 19556
Rivets wanted in England 19637
Roach destroyer 19381
Rock blasting under water *19250
Romulus, tomb of, discovery *19423
Roofing, copper 19304
Rope, wire, filler for 19556
Rubber, artificial 19523
Rubber goods, cement for 19556
Rubber, preparing 19000
Rubber stamps, blue printing 19589
Rudder, propelling *19321
Russia, land tenure in 19497
Rust on tools, prevention of 19556
Rays, X, in the army 19005
Rays, X, new use for 19369

S

Sail cloth, impregnating 19509
Salesmen, American, in Europe 19286
Salmon canning, Columbia 19588
Samoa, troubles of *19500
Samoan Islands *19494
Sand drift prevention 19304
Sante Prison, new cells of *19627
Santiago, mine defense *19530
Sarcophagus, Bismarck's *19474
Saw, diamond *19307
Saw, circular, guard for *19359
Saw, crosscut, hard wood *19395
Saws, wood, power of 19278
School for motormen *19254
School of anthropometry *19616
Schools, over-pressure in 19325
Schools, technical, Germany 19259
Scotland, trade suggestions 19572
Scotland, trade with 19429
Screw shaft, repairing *19390
Sea travel, therap. use of 19612
Searchlight, electric, new 19285
Secret of the harem *19375
Selenium, applications of 19636
Sensitizing solution 19004
Sesame oil 19325
Sewing machine motor *19391
Sewing machine oil 19004
Shaft coupling, Ballot *19379
Shaft sinking, Poetsch process 19285
Shampoo, eucalyptic ..... 19 '24
Shaving paste and soap 19573
Shearing machine *19379
Shells, engraved 19576
Shells, illuminating 19589
Sherry, essence of 19492
Ship canal statistics 19269
Ships, damage by galvanic action 19268
Ships, stopping, apparatus 19598
Shipbuilding, problem in *19249
Shipping, supply and waste 19106
Shoe blacking paste 19589
Shoe dressings 19445
Shoe trade in France 19637
Shoes in China 19524
Sierra Leone Railway 19633
Sight through nasal cavity 19488
Sign, track, new 19269
Signs, apothecaries, old 19612
Signs, electric light 19285
Silhouettes, Siberian 1-382
Silk, artificial 19330
Silk industry, French 19486
Silver mining and minting 19232
Silver, to dissolve, process 19413
Slate pencils, moulded 19556
Slating for blackboards 19285
Sleep, curative value of 19335
Sleepers, cedar 19316
Sleeping car comp. liability 19636
Smell, physics of 19068
Smoke consumption apparatus *19367, *19419
Smoke suppression 19331
Snails, remedy against 19398
Soap, dog 19461
Soap, Windsor, yellow 19573
Soaps, shaving 19573
Soaps, toilet and medicinal *19565
Sodor, liq., carbon dioxide *19273
Solder for glass 19525
Sounding apparatus *19410
Spark, electric, constitution 19411
Specters, luminous *19565
Speed time curves, best 19589
Spree, steamer, lengthening *19249
Spree, tunnel under *19558
Springs, indicator, test of 19624
Squid, the, in art 19508
Stains for wood 19349
Stains in half tones, removal 19492
Stamps, rubber, blue printing 19589
Statue of Rameses *19359
Steam accidents, France 19325
Steam generator, Turgan *19594
Steamer Fulton, United States 19344
Steamer Ultonia, engines of *19506
Steamship, most powerful 19636
Steel as a shaft casing 19269
Steel, etching on 19500
Steel, hard, drilling 19556
Steel, hardening 19492
Steel, magnet 19413
Steel plates, porosity of 19269
Steel, tempering in milk 19398
Steels, hardening of 19433
Stettin dry dock *19249
Stone crushers for Germany 19477
Stones, precious, to identify 19297
Store window washing 19609
Strains, torsional, measurement *19370
Strawberry, evolution of the 19337
Streets, asphalt, Germany 19588
Streets, New York, widening *19522, *19642
Streets, Paris, maintenance 19339
Student life, middle ages 19584
St. Gobain plate glass *19270
Suez Canal, traffic 19457
Sugar, beet root, discovery 19484
Sugar, making, old time 19332
Suggestion, mental, effect 19639
Sulphides, phosphorescence of ..... 196 '4
Survey, submarine *19410
Swords, Japanese 19616

T

Tacheometer, Bell-Elliott *19345
Tank, moving a 19604
Tapestry under Napoleon *19562
Tavolaro, state of 19624
Telegraph rates to Cuba 19445
Telegraphs, coast 19328
Telegraphs in Madagascar 19557
Telegraphy, aetheric 19506
Telegraphy, electro-optical *19533
Telegraphy, space 19328
Telegraphy, wireless *19452, *19528
Telegraphy, wireless, Marconi *19514
Telegraphy, wireless, Zickler 19065
Telephone, loud-speaking 19595
Telephone signaling, police 19049
Telephone, temperat. recording 19461
Telephone, the unwashed 19586
Temperatures, high, production 19553
Temperatures, low 19553
Temple of Karnak *19359
Tesla motor patents 19396
Textiles, market for, Peru 19444
Theater, new, at Vienna *19440
Theater, science in 19413
Tiber, bridges over the *19346
Tin plate, lacquers for 19492
Tire cement 19285
Tire, pneumatic *19262
Tires, bicycle 19433
Tobacco in Corea 19077
Tobacco, world's product 19433
Toboggan slide, railway 19049
Toning bath, photo 19257
Toning baths 19326
Tools, rusting of, to prevent 19556
Tooth powder, recipe for 19589
Torpedo boats, Japanese, names 19618
Torpedo boats, speed record 19368
Tower, Eiffel, improvement of 19326
Towing, electric *19269
Toy industry, Nuremberg *19393
Toys, mechanical, new *19359
Track elevation, Chicago 19349
Traction, cable, etc., New York *19642
Traction, electric, railway 19543
Trade competition, U. S 19429
Trade, Germany's assistance 19366
Trade in China, hindrances 19517
Trade, our, with China 19321
Trade, our, with Japan 19321
Trade suggestions 19397, 19420, 19429, 19444, 19460, 19477, 19493, 19517, 19524, 19541, 19557, 19572, 19588, 19604, 19625, 19637
Trade, U. S., in West Africa 19477
Trade with China 19641
Train, a high speed 19402
Tramway, electric, Java 19605
Transformer, Wydts-Rochefort *19081
Tree, determining when cut 19269
Tree, largest in the world 19508
Trepanning, ancient 19273
Troops, marching of 19333
Tuberculosis in animals 19356, 19366
Tubes, metallic, by extrusion *19442
Tunnel under the Spree *19558
Turbines, coal consumption in 19643
Turf briquettes 19604
Turkey, electricity in 19636
Turkey, our trade with 19637
Turkey, U. S. exports to 19524
Turning gear, electric turret 19074
Turrets, turning gear for 19304
Type setting machine, Cox *19451
Typewriter ribbons 19042

U

Ultonia, steamer, engines of *19506
Ultramarine, artificial 19515
Umbrellas, manufacture of 19462
Unio shells for buttons *19260
Urari poison, uses of 19629

V

Vanilla bean in Mexico 19660
Varnish and rope, Paraguay 19429
Varnish for gilding 19461
Varnishes, wood, recipes 19493
Vehicles, motor, heavy *19535
Venice, Micronesian 19274
Ventilating fan, a large 19525
Vertebrata, distribution of 19072
Vibrations, musical *19671
Victoria, electric *19002
Victoria, Queen, in France *19472
Vienna export academy 19025
Vogel, Hermann W *19313
Volcano, exposition of 1900 ..... *19447
Voltmeter, construction of *19480
Voltmeter, recording *19470
Vulcan, electric work of the 19253

W

Wagon, steam motor *19625
Wagons, American 19477
Walking on water *19022
War, Spanish-American 19440
Warships, motive power of 19501, 19507
Warts, how to remove 19333
Washing liquids 19525
Water courses, mountain 19326
Water, detection of 19381
Water filter, new *19329
Waterproofing canvas 19525
Waterway to Rocky Mountains 19624
Waves, tidal 19533
Wax, polishing 19624
Weather Bureau, British 19220
Weather observers, work of 19008
Wheat, oil of 19310
Wheat pastes in France 19625
Whitewash for brick walls 19005
Wind force, testing 19284
Wind, velocity of 19269
Windows, store, washing of 19009
Wine essences 19492
Wine in Algeria 19624
Wine manufacture 19624
Wire rope filler, new 19556
Women as inventors 19046
Women inventors 19633
Wood, seasoning of 19385
Wood, stains for 19349
Woods, American, Germany 19097
Wourali poison, uses of 19620

Y

Yacht, steam, Atmah *19343
Young, how to remain 19474
Yucatan, exploration in 19624
Yucca plant, Venezuela 19077

Z

Zinc industry 19366